Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LX FEBRUARY, 1921 No. 2

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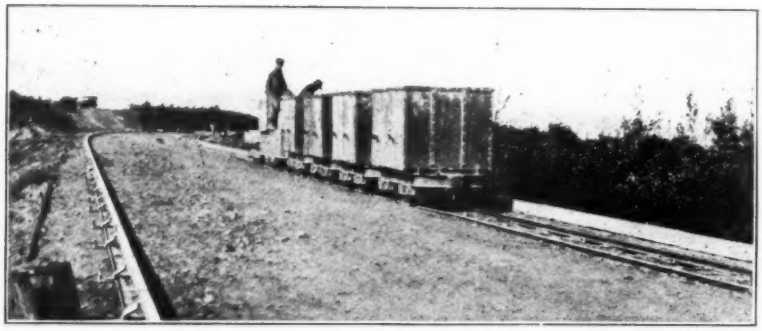

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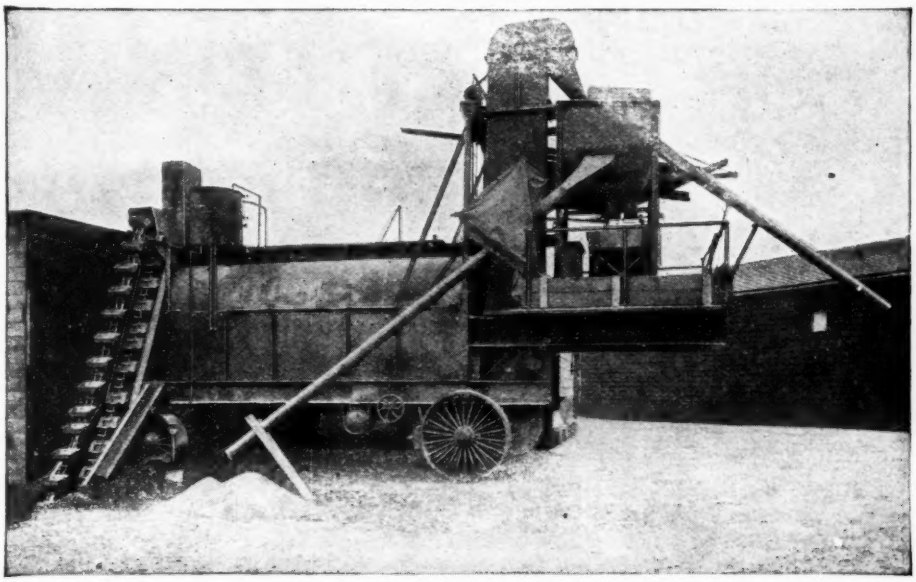

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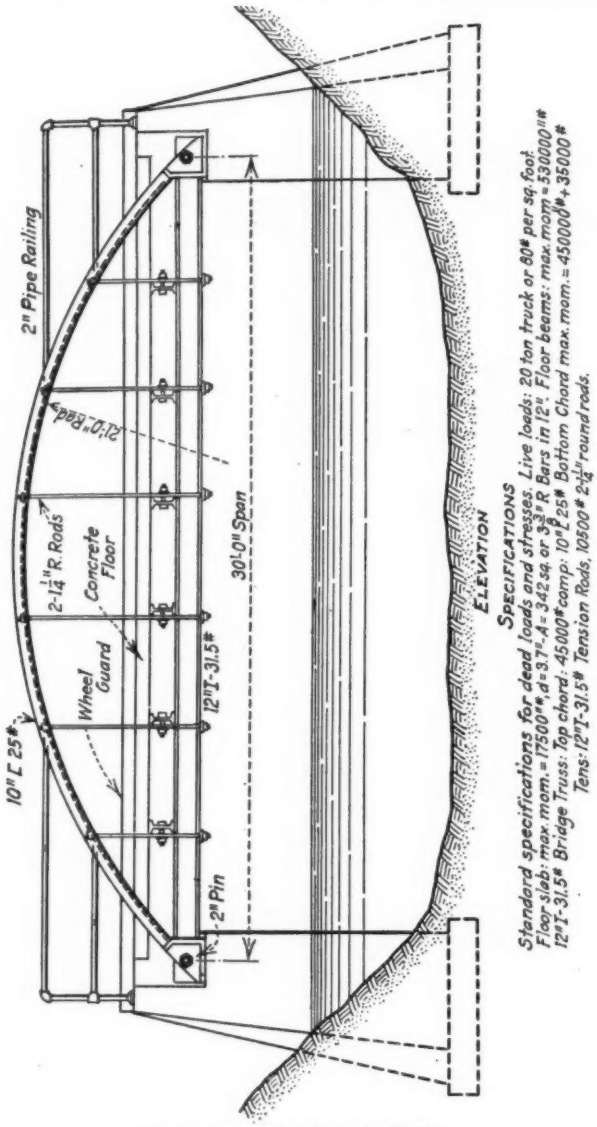
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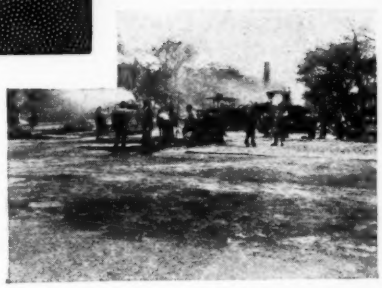

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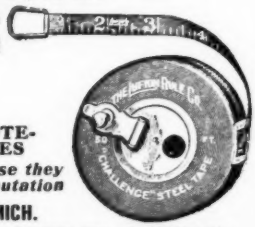

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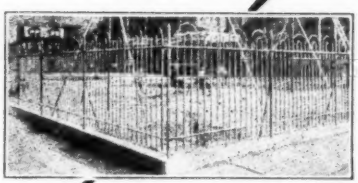

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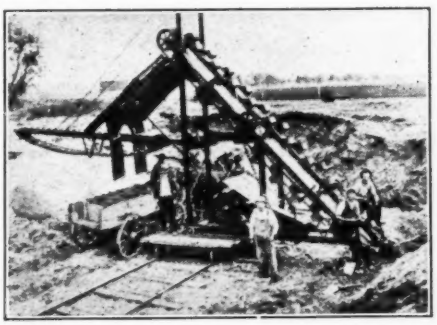

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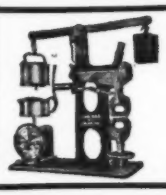

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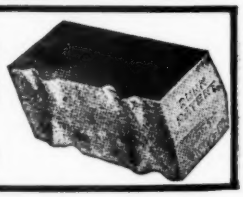
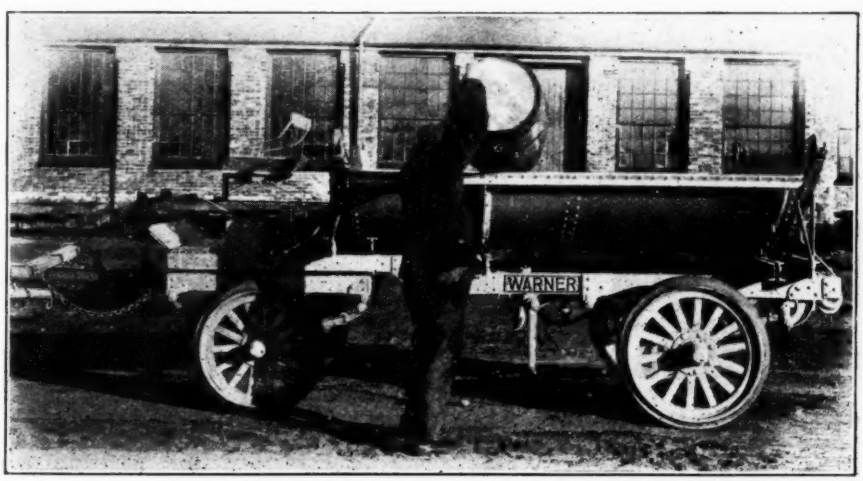


MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



NEW TWO-WAY SIDE DUMP BODY FOR HAULING ASHES AND GARBAGE.

Motor Truck Operation and Accounting LXVI

KEEPING HIGHWAY DEVELOPMENT ABREAST OF HIGHWAY TRANSPORTATION

The warning note struck some time ago by Chairman S. M. Williams, of the Federal Highway Council, against establishing highway transportation beyond highway development, is finding lodgment in traffic circles.

As a result, prominent traffic men cooperating with the Federal Highway Council are now taking hold of the transportation problem with a determination to insure the construction of roads around industrial and commercial centers that will prevent a return to congested conditions.

They do not propose, according to C. W. Reid, manager of the Transportation Bureau of the council, to be caught napping when the traffic tide begins to rise again. "For this reason," said Mr. Reid, many traffic managers throughout the country are going to give a closer study and a more determined application to the motor truck terminal zones as a cooperating branch of the railway and express service." Now that the railway express merger has been approved by the Interstate Commerce Commission, it is the belief that the next great step forward will be to throw short haul tonnage to the motor truck as fast as the change can be brought about along practical lines.

Rather than run the risk of getting the "cart before the horse," it must be understood that the policy of the Council is along the lines indicated by Chairman Williams in his statement at the recent conference held by the Council's Transportation Committee in New York.

"The Federal Highway Council," said Mr. Williams, "is working upon the belief that the future development of any type of transportation will largely depend upon the economic service which that type may render the communities served. We have heard a great deal about the short haul and the necessity for its being turned over to the highway. Articles have been written, columns have been published, and the public has been worked up to a fever heat over the tremendous possibilities of diverting the short haul to the highways. I fear, however, that the important part of the entire subject has been overlooked, that is the necessity for an improved highway.

"Admitting that the short haul freight is not a function of the railroads, and recognizing the necessity of relief to the railroads so that their equipment may be employed in the longer and more profitable haul, I do not feel that the Public Utilities Commissions of the various states will be willing to relieve the railroads of that responsibility until the public is assured of a substitute that will give at least as satisfactory and dependable service. With the exception of a few instances the highways of our country are not in position to assume the burden of the short haul now handled by the railroads, and therefore, is it not time to begin the promotion of this subject from the bottom, rather than from the top?

"I feel that as part of the very important work of this committee, it will be necessary for them first to analyze what intelligently constitutes the short haul. Secondly, they should ascertain by intensive study and investigation highway conditions in the various communities, with a view to encouraging the development of highways necessary to meet this specific traffic need."

Illinois Has Motor Truck Test Road Under Construction

The following interesting paragraph is from Bulletin No. 5, of the Illinois Highway Commission, recently issued:

The introduction of motor trucks has caused more confusion and uncertainty to the highway engineers designing road pavements than the change from the horse drawn vehicle to the passenger car. The questions which arise to confront the engineer today are: "Where is the economical limit for motor truck loads; and the corresponding limit for the type and thickness of the pavement?" "What is the load carrying capacity of the standard types of hard surfaced pavements of varying thickness?" In order to answer these questions with some degree of certainty former Governor Lowden has urged

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PIERCE-ARROW preeminence—as the truck which *lasts longest*—is recognized by all truck buyers. Most of them admit its superior economy and efficiency—the truck which *works constantly.*

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THE PIERCE-ARROW MOTOR CAR COMPANY, BUFFALO, N. Y.

that Illinois carry on some definite experiments looking to the solution of these problems. The construction of a test road, in which the federal government is co-operating, is now well under way. The road will be completed early in the summer of 1921, and the tests will be made immediately following its completion. It is believed that the results obtained will give a very definite idea of the value of the different types and thicknesses of pavement for carrying truck loads; and also will furnish a basis for deciding how heavy our pavements should be built, and the limits of the loads which should be carried thereon.

Automotive and Railway Relations

Railroads welcome the motor truck, according to the well-known "Railroad Review." This will be interesting news to the motor truck manufacturing interests. There has been reported in the past an apparent attitude of antagonism toward the commercial car in general. It has been claimed that where good roads were general, the truck was cutting into the tonnage of the railroads. "There was some reason for the general comment regarding the antagonistic feeling of the railroads for the motor truck," said W. G. Rath, of Napoleon Motors Company, Traverse City, Mich., "for wherever any section such as California possessed ideal highways in great system, making possible a wide-spread transportation of freight without recourse to railroads, the loss to the railroads in freight haulage was considerable. It is in cases where long distance hauling is possible that the railroads suffer. The latter now recognize that the economy in the use of motor trucks over moderate distances is not to be questioned. They are unwilling to grant the economy of truck transportation for long distances ,and their antagonism in districts where this is possible has hardly been questioned in the past. With the great additions planned to American highway systems throughout the country there can be no doubt that the railways will suffer a decline in business as the truck will prove much more economical, both in time and in handling of the goods. What applies today to moderate distances applies to long distances in California, and will apply elsewhere in the same way as road conditions improve, as they will do steadily."

Motor Truck Versatile in Road Building

Hauling gravel from the pits to points along the road is just one phase of the work performed by the 5-ton White truck owned by the county of San Luis Obispo, California, and another truck of like capacity operated on the same job by John Guy, hauling contractor. When all phases are considered, the effect is to establish the versatility of trucks and to define sharply the contrast between old and new in hauling equipment and methods, for struggling along with the powerful motor trucks a few teams of horses are still retained. Their presence affords an unescapable opportunity literally to measure the "horse power," the endurance and capacity for work of the motor truck.

Reduced to figures, the exact superiority of the 5-ton truck over the horse would read something like this, according to Supervisor E. C. Loomis, in charge of road work in San Luis Obispo County:

"Each truck daily made six round trips, averaging 13 miles in length, carrying between 5½ and 6 yds. of gravel. Four horses, pulling a wagon and 2 yds. of gravel, made two round trips a day, two teams thus transporting 4 yds. to every 35 hauled and spread by a single motor truck.

"Besides, horses tire quickly. They also consume an enormous amount of feed. Motor trucks are tireless, require little attention, and their upkeep cost is negligible when the amount of work they accomplish is considered."

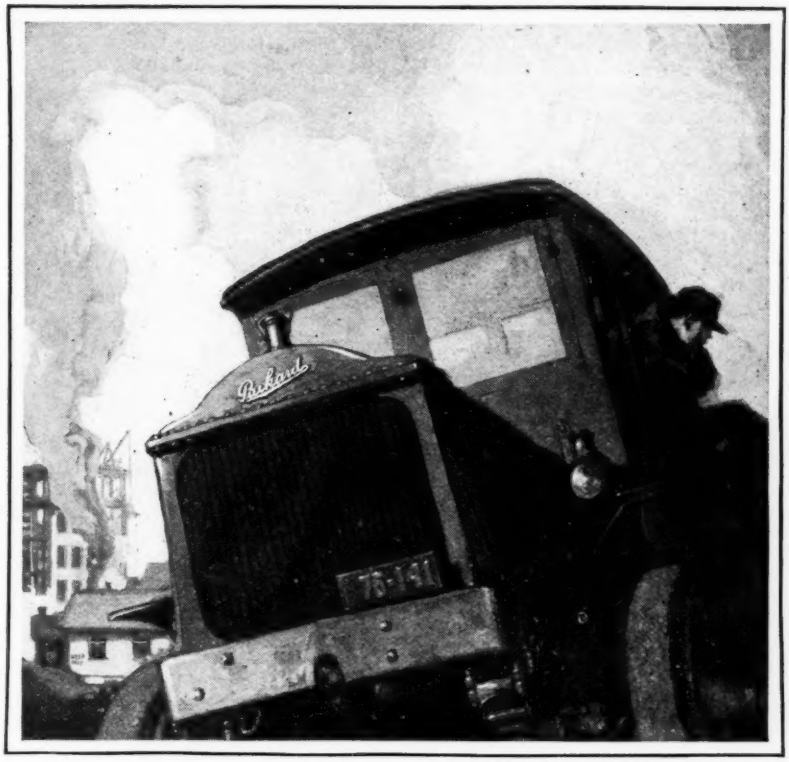
When not engaged in hauling gravel or spreading it along the road, the trucks are used in pulling road machinery or, equipped with 1,500-gal. in sprinkling the road.

The present method of excavating, loading, transporting and spreading gravel by motor truck is estimated to cost two-thirds less than in the days when horses were the sole equipment. Now, workmen plow up the tenacious gravel and scrape it within reach of the mechanical loader installed at the side of the gravel bank. A truck can be loaded and started on its way in ten minutes. Arrived at its destination, the truck distributes its load by means of the spreader which is part of its mechanism. During five months of 1920, eight miles of gravel were laid in San Luis Obispo County.

New Two-Way Side Dump Body

A new two-way side dump body constructed according to the ideas of various city engineers, is now being marketed by the Warner Manufacturing Company, of Beloit, Wis. The peculiar conditions attached to ash, rubbish and garbage removal in municipalities, have been given due consideration in the design of both

PACKARD



Investing Public Funds in Trucks of Proven Worth

Municipal officials, in specifying Packard trucks for fire, police, and public improvement work, are investing the public funds in motor equipment of proved dependability and worth.

In the city of Peoria, Illinois, for example, two Packard trucks have been in the service of the fire department for a year and a half.

During this time, one truck answered 396 alarms, at which 50,550 feet of hose were laid, worked 329 hours, and covered 808 miles. The other answered 222 alarms, at which 30,300 feet of hose were laid, worked 316 hours, and traveled 289 miles.

Public property has been protected by Packard truck speed and dependability. Public expenditures have been reduced by the savings in ton-mile and repair costs effected by this equipment.

Such performance has its source in the correct design of Packard trucks, the precise way they are built, the scientific manner in which each truck is specified to its job.

PACKARD MOTOR CAR COMPANY · DETROIT

Ask the man who owns one

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trailer and body. The combination of trailer and body is covered by patent. It is claimed that this equipment has been tested under the most severe conditions over a period of several months and has stood up well under the tests. The following features are claimed:

Low price. Interchangeability of the trailer equipment with other bodies for other uses. Simple construction in both trailer and body, guaranteeing low rate of depreciation and long life. Possibility of operating trailer and turning it around in narrow alleys. Simple body construction, assuring complete discharge of the load. Loading edge from ground, 2½ yd., 59 ins.; 3½ yd. body, 62 ins. When body is dumped, the lower edge of body clears the dumpage. Body is under constant control of cables, thereby eliminating the jumping off of body from the trailer. Quick operation, as it takes only 50 seconds to raise the body to complete dumping position, and after dumping, the body returns to its horizontal position by gravity.

Light weight of the entire outfit in comparison with the usual drop frame construction, which will permit hauling by mules or horses.

Motor Trucks are Bringing the "Wagon" Coal Mines to the Railroad

Now that the government, mine operators, miners and railroads are once more pulling together, the problem of coal transportation is again holding the attention of transportation and business men. In an investigation recently conducted by the Federal Motor Truck Co., of Detroit, Mich., some interesting facts concerning the transfer of coal from the wagon mines —mines without railroad switch facilities—to railroad sidings, were brought to light.

The new government rule specifying that wagon mines must receive their share of coal cars, but requiring the mines to load them within 24 hours, has compelled wagon mine operators to adopt more efficient methods of loading and delivering their coal, and most of these mines are now operating trucks instead of their old horse equipment.

While the saving in time that the trucks effected is interesting and important, the investigations produced some interesting comparison of costs between the new and old methods. These costs, of course, vary in different localities, but a fair average of the cost of the horse and wagon equipment showed that it cost approximately $1.50 per ton to haul the coal to railroad sidings. The use of trucks lowered this cost to approximately 50 cts. per ton, and made a saving in the total cost of mining coal of from $3.55 per ton to $2.55 per ton, or approximately 28.2%. The methods of unloading trucks at the sidings were also carefully studied. It was found that special facilities for unloading were necessary. Accordingly the Federal Motor Truck Co. designed a special elevating dump body by which the truck load was lifted mechanically to a level with the top of the gondola cars and could be dumped in from 1 to 3 minutes. Unloading the same load by hand usually required about 30 minutes.

Figuring Truck Depreciation

"Five years from now this motor truck will be off the roads, hence it must also be off our books."

Thus, arbitrarily, the cost accountant was formerly wont to give any new motor truck his employer might purchase five years to toil, depreciate and finally disappear, after having returned its original cost, subsequent upkeep and a tidy surplus for profit.

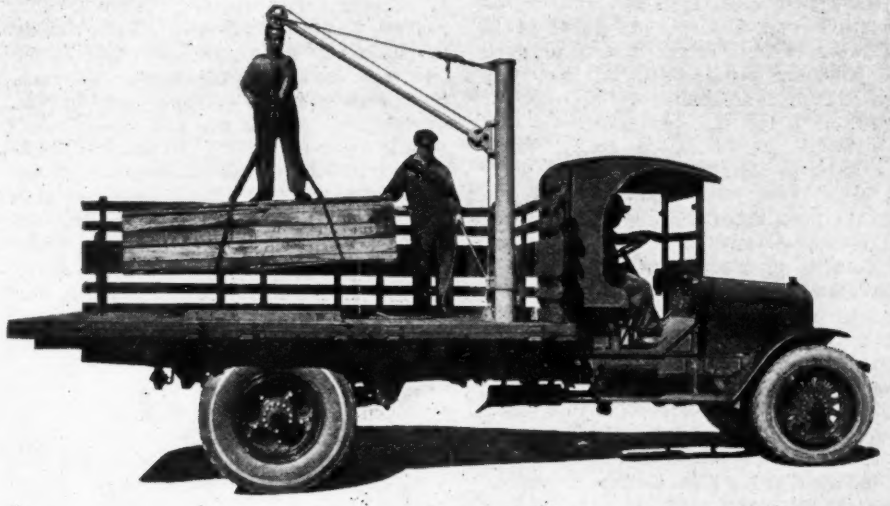
So far, so good. But five years later the error in such an inflexible cost system became apparent, for the motor truck, if it was a good truck, refused to retire from active duty despite the fact that, theoretically, its working days were over.

In fact, so many trucks that went into service 10 years ago are still working and earning, years after they have written their original cost off the books, that a few cost accountants have chosen to measure truck longevity by miles rather than years. Age yielded to mileage as the unit of measure—and 100,000 miles was considered a liberal allowance for a truck.

But once more matters were complicated by the good trucks, for so many of them rounded the 100,000-mile post and kept right on going that the record ceased to excite wonderment. For instance it is announced that 533 Whites still in service are known to have traveled 100,000 miles; 106 have exceeded 150,000 miles; 94 are somewhere on the 200,000 to 300,000 miles lap; while 25 trucks have forged ahead of the field, well beyond the 300,000-mile mark. The figures in each group are approximately double those revealed by the 1919 tabulation of letters from owners.

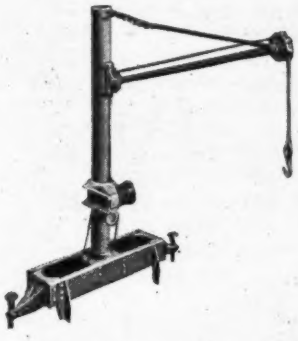
Truck Makes Good Record on Road Work

Mr. J. D. Harvey, sales manager of the Southern Clay Manufacturing Co., Chattanooga, Tenn., recently gave the follow-



MEAD-MORRISON SERVICE

A trained staff of engineers gives its attention entirely to obtaining maximum usefulness from equipment in the hands of clients.



Cranes for Motor Trucks

Mead-Morrison are known as builders of practical, time-saving hoisting and loading apparatus for motor trucks.

We are now producing the Mead-Morrison Motor Truck Crane. The one illustrated here is particularly adaptable for loading bales of wool, cotton, lumber—short lengths, crates, boxes and general merchandise. Its time- and labor-saving value is remarkable.

In addition to the crane shown above, we make a heavy-duty Single Line Motor Truck Crane suitable for general use, including lifting magnet and grab bucket work.

Our representative will gladly call and give you complete details.

MEAD-MORRISON

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226 Prescott St. East Boston, Mass.

DISTRIBUTORS

Martinsville, Va., American Truck Body Co.; Pittsburgh, Pa., Auto Truck Equipment Co.; Los Angeles, Cal., Edward R. Bacon Co.; San Francisco, Cal., Edward R. Bacon Co.; St. Louis, Mo., Hummel Mfg. Co.; Long Island City, N. Y., Interboro Hoist & Body Co.; Baltimore, Md., Kunkel Service Co.; Detroit, Mich., Mansfield Steel Corp.; Philadelphia, Pa., Motor Truck Equipment Co.; Indianapolis, Ind., William Ogden; Springfield, Mass., Springfield Commercial Body Co.; Cambridge, Mass., Springfield Commercial Body Co.; Cleveland, Ohio, The Truck Engineering Co.; Richmond, Va., Virginia Truck Body Co.; Chicago, Ill., Wisconsin Motor Parts Co.

MEAD-MORRISON

LIFTS THE LOAD OF INDUSTRY

ing information on the performance of a 2-ton Federal truck on road work:

"Have just looked up our records on the truck and find we purchased it in December, 1916. From that time until this date, our repair parts bill has only been $119.56, and some of this was for repair parts for the dumping hoist and an oversize set of piston rings. From Dec., 1916, to Jan., 1919, our repair parts bill was $9.06. The remainder of the cost has been since then, or in the third and fourth years of this truck's service.

"We have used this truck hard—it has been on all the paving and road work done by us in Florida and Alabama in the last four years. We still have the original set of tires on it. On our Volusia County, Fla., job we handled over 10,000 tons of shell alone with this truck in addition to a large quantity of other material. At Troy and Enterprise, Ala., we handled about 15,000 tons of paving brick, 12,000 tons of sand, gravel and rock, and 5,000 bbls. of cement. It is now doing good work every day on a road job near Milton, Fla., hauling sand, slag and cement, etc., through heavy sand over as poor a road as I ever trucked over.

"I don't recall of this truck ever being in the shop, and believe that all the repairs necessary have been done by the drivers. The motor has never been down except recently to install oversize rings. In addition to work service, the truck has been driven cross country from job to job, hauling men and camp outfits. Some of the trips were over 300 miles.

"We feel we have gotten our money's worth out of this truck. I only wish all our trucks had given us half as good service as the 2-ton Federal. After this job is finished, will need a new set of tires all around, and believe large pneumatics would be the thing."

3½-Ton Truck Saves $1,300 *per year Over Horse Hauling*

"Motor trucks have a distinct advantage over horses for a business requiring irregular hauling," says Mr. E. O. Johnson, one of the proprietors of the Anchor Stone Co., of Minneapolis, Minn.

"A horse will do just so much work a day, and then he is through. He eats as much whether he is standing in the barn half the time or out on the road all day. A good motor truck will go fast and far and long as you want it to. When it isn't working, it costs you nothing for gas and oil.

"This difference is particularly noticeable in our business, which is the manufacture of concrete laundry tubs and concrete building blocks. Our work is done on order, so that the daily amount of hauling varies greatly. When we are rushed, it would take two 2-horse teams to make our deliveries; at other times one team could do the work. A truck is flexible enough to take care of the fluctuation. Horses are not.

"We are using a 3½-ton Garford, purchased in the latter part of 1916, so that it is nearly four years old. We also have a small light car for running errands, but the truck does our real work. It delivers building blocks and laundry tubs on order; and when in a pinch our sand supply runs low, it goes out and brings in a load.

Makes Capacity Deliveries Over Unpaved Streets

"When the truck is hauling stone, it is loaded to capacity. It's never overloaded, however, no matter how big our rush, because we know that doesn't pay. Only this morning I saw a truck go by here carrying a double load and running at top speed. That driver is a fool, and the owner of the truck is going to have a big repair bill. Most of our work is done for construction jobs, and in making deliveries it is often necessary for the truck to run over unpaved streets and into vacant lots where the going is bad. This means hard usage for a truck. Our driver never runs faster than 12 miles an hour, and usually he goes slower.

"The truck travel 29.6 miles a day on the average. This is not bad, considering that it often works only part time, and seldom makes long trips. Occasionally it goes to St. Paul, 12 miles from our plant, and it has made longer runs that we would not attempt with horses. But most of our jobs are located near the plant and the chief demand on the truck is for many short deliveries.

Does Heavy Hauling at a Cost of $11.46 *A Day*

"In spite of the rough usage it frequently gets, our truck is practically never in the repair shop. The first two years its total repair bill was only $25.62. The third year we gave it an overhaul at a cost of a little over $200. We estimate $175 a year for maintenance and repair. The actual repairs certainly will not exceed this amount, and the driver maintains the truck when it is idle.

"During the year ending July 1, 1920, the truck worked 270 days and traveled a total of 8,000 miles. Our operating cost, based on the National Standard Truck Cost System, was only $11.46 per day, including $5.81 for driver's wages. Such

a remarkably low cost for a 3½-ton truck doing heavy hauling is one reason why we think so much of our truck.

Saves $1,300.00 a Year Over Cost of Horse-Hauling

"A 2-horse team capable of doing our work would cost us $12.50 a day with driver, or $1 a day more than our truck. This is a saving of $270 a year for the 270 days the truck actually worked. But our rush periods, when we should need two teams, would approximate one-third this time, or 90 days each year. If we could get that additional team for only the 90 days when it is absolutely necessary, it would cost us $1,305 a year. So our truck actually saves us $1,305 a year on our hauling, so that it more than paid for itself the first three years.

"In addition to this cash saving, we must give the truck credit for increased business range and capacity, and greater flexibility in making deliveries. All these factors have definitely helped in extending our business."

STUDY AND TREATMENT OF HIGHWAY SUBGRADE AND FOUNDATIONS

By Charles M. Upham, Chief Engineer, State Highway Department, State House, Dover, Del.

The subject of subgrade and foundation construction is not a new one, for there are many evidences that attention has been given to this detail ever since the art of road building has been recorded. In practically every instance, however, this detail of construction was masked under the name of "drainage," a detail always recognized as of great importance, much talked about, but not ordinarily practiced.

A few years ago many of the failures in roads were type failures, which meant that the pavement did not have the inherent strength to withstand the demands of traffic, even though supported on a stable foundation or subgrade. In other words, the surface pavement broke down under traffic.

Although we have now developed road surfaces that satisfactorily carry the present-day traffic if properly supported, we still find there are failures of these standard types.

During the period of lighter traffic many standard types of road surfaces were developed that carried the traffic satisfactorily, even on the less stable subgrades; but with the coming of the heavier types of vehicles it was found that these standard types of pavement would carry the heavy traffic only over well-drained and stable subgrades.

While much has been said and a certain amount of research has been made on drainage problems, it is quite obvious that until recently the greater concerted study has been made on pavement surfaces, and comparatively little complete investigation has been carried on relative to stabilizing the subgrade or road foundation.

Problem of Subgrade Stability

Within our present knowledge of permanent surfaces we can with reasonable limits compute the strength and resistance to traffic, provided we know the condition and nature of the subgrade; but when we inject the varying factors that influence the stability of the subgrade, the conditions present a new problem, one composed of many variables and difficult to solve. The high first cost of road construction and the excessive cost of road maintenance make it necessary that a determined effort to solve, if possible, the question of stabilizing the subgrade, no doubt the most complicated problem yet remaining in road building.

Some engineers have recognized for several years that different soils and soil conditions present varying degrees of stability in the subgrade. Various methods have been followed in the subgrade treatment, but in general standard pavements have been laid on subgrades of different degrees of stability. In some cases the subgrade was not sufficiently firm to support the pavement and traffic, and in others the subgrade was of such a nature that a cheaper pavement would have been sufficient. This practice produces an uneconomic condition, which is not flattering to the highway engineering profession, and must be corrected as quickly as possible, if we do not wish to bankrupt every state in the Union before our state highway systems are completed.

Present Terminology

In this paper the pavement is considered the artificial surface, the road foundation as that part of the subgrade that has been replaced or treated, and the subgrade as that part of the road beneath the road foundation.

In general the strength of a pavement is a function of its depth; therefore, any increase in depth will materially strengthen the pavement. It would probably never happen that the foundation would be as strong as the pavement, but the nearer the foundation approaches this condition, the greater would be the strength of the pavement, for the foundation would

act in a proportionately greater capacity in assisting the pavement to resist traffic forces. The same holds true with regard to the subgrade in stabilizing the foundation, which, in turn, stabilizes the pavement.

It would be practically impossible to classify all the various kinds of subgrade materials.

The wide range is evident on roads that have failed. Many times a standard pavement has failed in spots or short lengths, although the entire road has been subjected to the same traffic. Apparently this is due to the fact that the foundation or subgrade is not as stable in these places that have failed as elsewhere. These failures afford opportunities for the study of subgrade and foundation treatment, as well as road surface design.

Thin Layer of Clay Causes a Failure

An interesting example of this is a bituminous macadam road that has been failing in certain points for a lengthy period. The majority of the soil in this vicinity was easily drained and the subgrade close to the pavement seemed satisfactory, but further investigation showed an impervious layer of clay, not over 1 in. in thickness, lying in a generally horizontal position, which prevented moisture from draining away from these points in the subgrade where the failures occurred; or, in other words, there was retained sufficient moisture to make the subgrade unstable at the points where this impervious material became a part of the subgrade, thus producing a condition which caused the pavement to fail.

Below this impervious layer of clay which retained the moisture was a sand that was easily drained. Had this clay been removed this sand would have afforded a stable foundation that would undoubtedly have prevented the pavement from failing.

Subgrade Testing Instrument

Such mistakes as this could probably be brought out and corrected by means of some subgrade testing instrument. At the present time there are several tentative designs, some of which afford means of securing many valuable data. There is much to be done in perfecting these instruments, however, due to the variation in results obtained when different degrees of moisture are present. It is not possible to control this factor by artificial moisture, for the results would not be comparable, due to the fact that different amounts of moisture do not have the same effect on the stability of different soils. Thus it can be seen that the results obtained from subgrade testing instruments are at present only comparative, and reliable only between very narrow limits. Some instruments for testing subgrades have shown results varying as high as 200 per cent. where the difference of the amount of moisture was not sufficient to be perceptible to the eye.

Stabilizing the Foundation

The subgrade problem resolves itself into stabilizing the foundation either by draining, by excluding the moisture, or by constructing a foundation course. Whichever method is followed simply increases the effective depth of the road surface or pavement, inasmuch as the stabilized foundation or subgrade will act as increased depth of road surface. The problem consists of deciding just how much should be spent in the drainage and how much should be spent in stabilizing the subgrade.

It seems perfectly proper to assume that the bearing power or stability of most soils is increased by the absence of moisture, so our problem can be more easily solved if we minimize the amount of moisture in the subgrade. The moisture enters the subgrade from the surface in the form of rain, from the sides as seepage or horizontal capillarity, or from the bottom as vertical capillarity, or, as in the case of grades, by following along impervious strata which intersect the road surface or foundation.

It would be a simple matter to take care of the water that enters the subgrade from above, as this would mean simply the waterproofing of the surface and shoulders, and the results obtained would be far in excess of the effort and the cost expended.

The water from side seepage or horizontal capillarity could be taken care of by an intercepting ditch or tile and stone drain. This would mean that the only other source of disturbing water is from below, and this is the difficult portion of the problem to solve.

Capillarity

In many soils capillarity will draw the water from 2 to 5 ft. in comparatively large quantities. Some authorities claim that the capillary action will extend many feet more. It is quite likely that this capillarity, assisted by the vibratory action of traffic, would cause sufficient moisture to rise in the subgrade to render it unstable. There have been many attempts to break up the capillarity, some of which have been successful; this reduces the problem to a certain extent. Experiments have been tried by placing a layer of ma-

terial of low capillarity beneath the pavement. The tendency is to prevent the moisture from rising above this layer, thereby giving greater stability to the foundation, which is in a degree equivalent to increasing the thickness of the pavement.

These are conditions that exist at different seasons of the year when the subgrade or foundation is weakest. This is when the subgrade is saturated with moisture, which usually occurs during the spring thaw. If the ground has been frozen and is suddenly thawed, there is a layer of saturated subgrade directly above the frozen material. That this is the worst condition that may exist is evidenced by the general breaking up of the roads in the spring of the year. Subdrainage under these conditions is of little value. This condition is best overcome by open ditches, allowing the water to run off as soon as the frozen material is melted.

If the conditions are such that the subgrade or foundations cannot quickly dry out, the pavement, almost regardless of type, will have a tendency to fail. If the subgrade cannot be quickly drained, then one of the best methods of stabilizing the subgrade is to build up a foundation with a material of high bearing value, capable of carrying the load.

Some Methods Successfully Used

In some States it is customary to build a foundation using rocks varying in size from 3 to 15 ins. Although this method of treatment is costly, it is very effective, and many roads with these foundations have been carrying heavy traffic, although surfaced with only a medium heavy pavement. While a foundation of this sort can stand considerable moisture without deleterious effects, still a constant effort should be made to exclude moisture.

Another method that has met with success is by replacing the unstable subgrade with a layer of a higher bearing value material, such as gravel or crushed stone. This not only stabilizes the foundation, but prevents water rising so high by capillarity. Also, it provides a means of drainage should the moisture for any reason rise in large quantities into the foundation.

Another method of treatment, though possibly less effective, is a replacement of unstable subgrade with sand. This also tends to decrease the capillary action and additional drainage in some cases should not be necessary.

Waterproofing the Subgrade

Capillarity is dependent on the size of the pore spaces between the particles. If these are large, then capillarity ceases; if they are filled with certain material, then capillarity ceases. This suggests a method of treatment of the subgrade such as filling the subgrade with some waterproofing material. If the subgrade can be stabilized by this method, then the effective depth of the pavement is increased by the amount that the subgrade has been stabilized. A number of experiments of this nature are now being conducted by the Bureau of Public Roads, the results of which are bound to be of much interest and great importance.

There are undoubtedly many small details that could be followed that would assist in the stabilizing of subgrades. It has been shown that by plowing or breaking up the surface moisture will be retained. Therefore, it would seem that the reverse should be true, and to exclude moisture the subgrade should be thoroughly rolled and compacted.

Another place where this subject can be effectively handled is in the establishing of the grade line. Keep the grade high unless, by making a cut, an impervious material can be removed from the subgrade and pervious material secured.

Direction Studies Are Taking

It cannot be hoped that a single paper can more than touch the salient facts of this subject, as great questions are yet to be solved. The treatment of subgrades will depend on the results found in the experiments on the bearing power of soils; on experiments to prevent capillary action; on results obtained in underdrain experiments. In other words, there are so many questions that must be solved, or partially solved, before the question of economically treating the subgrade and foundation can be completed.

Our present knowledge of the subject assures us that the stability of the subgrade or foundation depends upon the amount of moisture in the subgrade; the sandy or gravelly soils are more stable, but in order to stabilize the clay soils, they must be kept dry or replaced with different material. The design of the subgrade or foundation will always depend upon the drainage, and the engineering problem is to decide whether it is more economic to treat or replace the subgrade material, or to provide elaborate drainage, or a combination of the two.

This paper by Mr. Upham was read at the annual meeting of the American Association of State Highway Officials, held in Washington, D. C., on Dec. 14, 1920.

Start construction early-Move materials NOW

Avoid the Construction Difficulties of 1920

CAN unprecedented demand for construction materials overhangs the market. Once released, this demand can be met satisfactorily only through cooperation of the various agencies interested.

Owners and public officials must mature plans quickly, so that

Contractors can order material early
Dealers can build up stocks
Manufacturers can ship promptly, and
Railroads can handle business offered quickly.

Had such a policy prevailed throughout the period since the armistice, the difficulties experienced in carrying on construction work during 1920 would have been considerably lessened, if not entirely avoided. Contracts for an enormous peace-time construction program were awarded too late in 1919 to permit of completion during that year. This deferred demand came upon an unprepared market and was carried over into 1920, only to be still further hampered by the large construction program of that year. Not only was the greater portion of 1919 lost, but the construction industry impeded by railroad congestion was thrown into such turmoil in 1920 that only a cessation of contract letting could clear the situation.

Five years' accumulation of construction still awaits contract letting. If such contracts are awarded early in 1921 and construction proceeds in an orderly, intelligent and efficient manner, material manufacturers and railroads can meet the situation. Unless this plan is followed, difficulties even more serious than those of 1920 can be expected. You share with others a measure of responsibility in preventing a recurrence of such a situation.

Due to handicaps beyond its control, the cement industry operated at only approximately 70 per cent of capacity during 1920. Notwithstanding earnest and sustained effort on the part of cement manufacturers, many users were disappointed due to their inability to get shipments when and where wanted.

Transportation is the neck of the bottle regulating capacity of industry and distribution of its products. Cement is now available everywhere. Manufacturing capacity has always been equal to any calls made upon it unless demand has been concentrated within comparatively short periods.

There's no time like Now to move materials.

PORTLAND CEMENT ASSOCIATION

Atlanta				San Francisco
Chicago	Detroit	Los Angeles	Parkersburg	Seattle
Dallas	Helena	Milwaukee	Pittsburgh	St. Louis
Denver	Indianapolis	Minneapolis	Portland, Oreg.	Vancouver, B. C.
Des Moines	Kansas City	New York	Salt Lake City	Washington

Start construction early-Move materials NOW

EDITORIALS

SHIP CONSTRUCTION MATERIALS NOW

High railway officials are now admitting that there is, for the present, a surplus of rail transportation facilities. This is indeed a great change from the assertions of rail men, only a few months ago, that some years must pass before rail equipment could be made sufficient to the country's needs. Recognizing much political and other forms of propaganda in all railway utterances in recent years, it seems true that the steam lines now need business. An important publication, devoted to railway interests, is conducting a "Ship Now" propaganda and as that publication usually speaks with full, inside knowledge on all rail topics it is fair to assume that the roads do need business and can therefore handle the business brought to them by the construction, or any other, industry. Since it appears that the railroads can handle the shipment of highway and other construction materials now it is clearly wise to move as much material as possible in advance of the opening of the construction season.

In recent editorials we have urged this action and there is no occasion for repeating the supporting arguments previously advanced in this connection. The public wants a record-breaking output of new roads in 1921 and if this result is to be achieved it is essential that the materials be at hand when and where wanted.

The very mild winter, with its freedom from ice and snow, has facilitated rail transportation and enabled the roads to keep up with the demands made on them. The same cause has decreased the movement of coal, thereby easing winter traffic requirements. The rail rate advances have overreached their mark and the law of diminishing returns has at last come into operation. The industrial depression has also lessened the volume of rail business. So, for a variety of reasons, the steam roads are looking for business and it is to the interest of the construction industry to take advantage of this opportunity to get good service from the railroads.

Other big shippers are preparing to grasp the opportunity at this time. While the railroads are now looking for business it does not follow, by any means, that they will be so situated in the spring. With the gradual improvement in industry now apparent will come a gradual increase in railway business. The 1920 crop is yet to be moved. It may easily happen that by the time the construction season opens the railways will have good business again; if so the construction industry will not be the most favored shipper.

To take advantage of this opportunity award contracts as soon as possible and ship the requisite materials immediately thereafter. It will be a matter to regret if this is not done.

THE PUBLIC INTEREST IN PROPER COMPENSATION FOR ENGINEERS

In many of our editorials on the compensation of engineers we have tried to emphasize the fact that it is to the interest of the general public to pay adequate salaries to engineers so as to get and hold good men. An illustration of this point, possessing much dramatic interest, comes to us now in the announcement of the resignation of the State Highway Engineer of Wisconsin.

He has been in office 14 years and is widely and favorably known as a competent and conscientious public official. He has had very exceptional experience and his powers may be said to be at their zenith now. At just this time his state has much money to spend on road construction; half as much, in fact, for the year 1921 as for the years from 1912 to 1920, inclusive. Surely it is unfortunate for a state to lose such an official under the circumstances.

We can only hope that the public will heed the lesson taught in this resignation. Mr. Hirst has issued a statement explaining why he decided to take this step. It has been widely published and perhaps the people of Wisconsin will appreciate the significance of his sacrifice.

After telling of his natural pride in the work he has accomplished and of his pleasant relations with all his associates, his statement says that despite the fact that his work has not been profitable in terms of money and that it has been hard and, at times, extremely trying, he would, nevertheless, gladly have continued for the rest of his active life had he felt reasonable assurance that public sentiment would support the legislature, the highway commission and the county boards in the payment of salaries adequate to maintain organizations of the proper capacity to handle with efficiency the tremendous expenditures ahead.

To quote from his statement:

"A proper organization to control this kind of construction enterprise cannot be political, it cannot suffer too great annual changes in personnel. It must be an organization able to meet on an even footing of brains, training and experience, the best organizations that the manufacturers of road machinery and materials can buy. It must be able to stand knee to knee with the best and worst contractors and get for its clients, the people of Wisconsin, good construction at a fair price. The public must equip itself with eminently fitted representatives in this struggle, or the losses in poor roads and unjustified prices will be appalling.

"I had hoped to build up such an organization for Wisconsin. Until the public mind grasps the situation and supports a proper scale of salaries in the public service, I am convinced that I cannot succeed. As fast as I train men, the best are picked for service in the commercial field. In 1920 the Commission lost 27 per cent of its principal employees, and indications are that the losses in 1921 will be even greater. This will continue to be the case until the public realizes that it must protect itself by paying more nearly the market price for highway training, business experience, brains and energy."

The statement is too long to quote in full but its general character is indicated in the two paragraphs quoted. One must admire Mr. Hirst's presentation of the case as well as his courage, and his devotion to the public interest even in resigning his office. The case for the trained, well paid public servant has never been stated better than Mr. Hirst has stated it and we shall watch the effect of his action and his arguments, on the people of the exceptionally progressive and enlightened commonwealth of Wisconsin, with the very closest and liveliest interest. If the public can anywhere be expected to rise to such an occasion it is in Wisconsin. Here is a chance for that magnificent State to set another mark for the rest of the states to shoot at as it has so often done in other matters in the past.

ROAD SHOW SUCCESSFUL

The 1921 Road Show, held in Chicago, Feb. 9-12, was a distinct success in the opinion of exhibitors and visitors. A good deal of equipment was sold on the spot and many good prospects were discovered. In all our years of exhibiting copies of our magazine at conventions and shows we never saw the demand for it that existed at this road show. In fact the very liberal quota of copies set aside for this use was exhausted before the show ended. Other publishers had the same experience, of course.

These matters are worthy of note as evidence of a very great interest in everything pertaining to road construction at this time. Undoubtedly this will be the greatest year the highway field has ever known, with useful work and plenty of opportunities for everybody.

END OF THE NEWER MUCKRAKING

There are evidences that the newer muckraking has about run its course. Let us hope so. We refer, of course, to the damning of the federal government, for everything it does or refrains from doing, and everybody connected with the government whatever his past conduct or creed. Since the signing of the armistice until very recently there has been one tirade after another "agin the government" and these assaults have not added much to the reputation of the American people as "the best half-educated lot in the world."

Recently, in Washington, Gen. Dawes made himself very popular by denouncing further partisan criticism of the conduct of the war. The favorable popular reaction to this suggestion was very marked, although he didn't say a word which any rational adult might not have said two years ago. The way the country enjoyed the cussing he administered to the "smelling" committee is a good indication that the muckraking of the government is about over. Let us all give the new administration our best wishes, and our loyal support.

THE PRE-CAST CONCRETE SLAB PAVEMENT ON CASPER-SALT CREEK, WYOMING, ROAD

By C. H. Bowman, District Superintendent, Wyoming State Highway Department, Cheyenne, Wyoming.

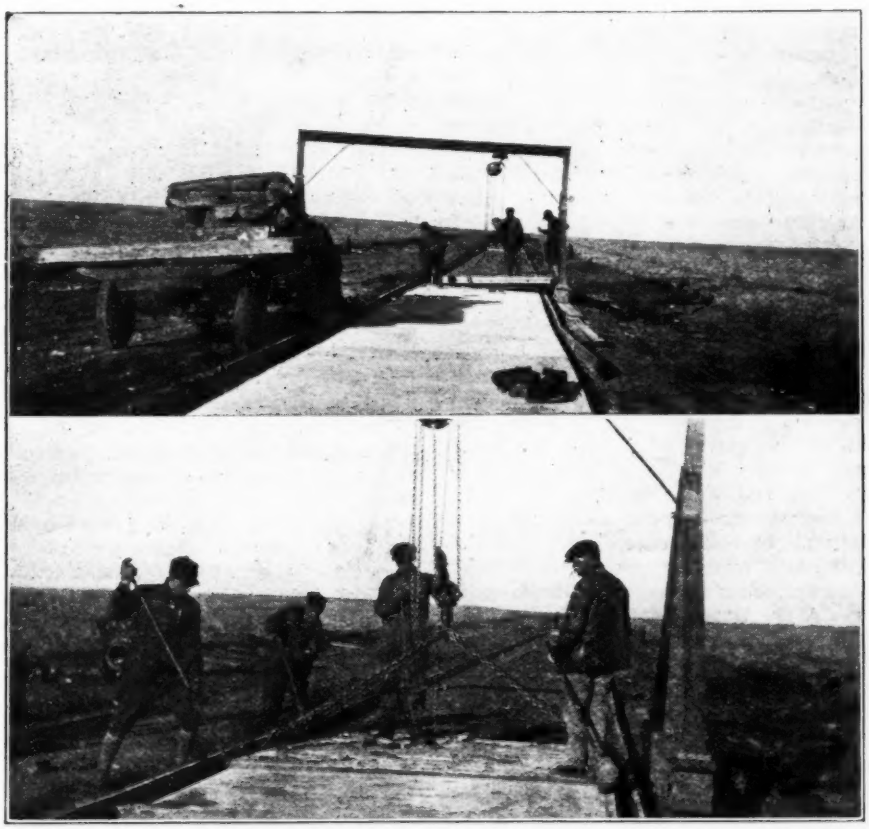
Twenty-four hundred feet of experimental concrete pavement was laid in place and put in service between Casper and Salt Creek Oil Field, on State Highway No. 71, during the month of December, 1920.

Oil was discovered in the Salt Creek oil field, 44 miles north of Casper, now known to be one of the best fields in the world from a producer's standpoint, in 1886. Active development started in 1911. With the beginning of drilling operations the trail between Casper and Salt Creek was soon lined with many string teams hauling building material, oil well and commissary supplies.

First Truck Appears on Trail

In the year 1916 the first motor truck made its appearance on this trail. Teamsters with their 16 to 24-horse string teams, who had struggled with their loads of freight across the sticky gumbo flats during the spring thaws and across the sandy stretches in the hot, dry summer months, predicted speedy disaster to the interloper. However, despite high centers and bad road conditions this truck stayed with the game and from that time on trucks increased rapidly in number, while the number of string teams decreased correspondingly.

With the arrival of more trucks in the hauling field the agitation for road improvement began, and as a result, in 1917 the county, state and Midwest Oil Company joined in a Federal Aid project reaching north from Casper 39 miles. This 39-mile stretch was graded and provided with proper drainage structures and the first 5 miles north of Casper was paved with concrete 16 ft. wide, this work being finished in 1919. During 1920 the remaining 5 miles to Salt Creek was graded and drainage structures installed preparatory to paving.



LAYING PRE-CAST CONCRETE SLAB PAVEMENT ON CASPER-SALT CREEK, WYOMING, HIGHWAY.

Heavy Motor Traffic

While these improvements greatly facilitated the motor vehicle traffic, the great increase in number of vehicles made the transportation problem an increasingly difficult one. By late spring of 1920 the tonnage passing over this road had increased until in a single month the Midwest Oil Company, the leading producing company in this field, loaded out 6,000,000 lbs. of freight from their warehouses. A very conservative estimate of the tonnage hauled by other companies during the same month is 4,000,000 lbs. Add to the motor trucks required to haul this tonnage another 100 motor vehicles per day passing over this main north and south state road, and the necessity for a hard surface road of the very best type is apparent.

Concrete Pavement Planned

Plans were made by the State Highway Department for a concrete pavement the remaining distance of unpaved road, 39 miles to Salt Creek. Thorough investigation of the country on both sides of the road developed the fact that the only source of supply for aggregates was in the gravel bars of the Platte River at Casper, and that there was no dependable source of water supply anywhere north of Casper on this road. The long haul for aggregates and other materials, the necessity of a heavy expenditure for pumping plant and the scarcity of labor during the post war conditions of 1918 and 1919 prevented the State Highway Department from going ahead with this work.

Idea Conceived of Casting Pavement in Slabs

While the State Highway Department was conducting studies of the surfacing problem on the Salt Creek Road, the idea was conceived of casting this pavement in slabs at Casper, the source of aggregate and water supply. By so doing the pavement could be placed at a minimum of interference with traffic, a minimum of camp expense, a minimum of equipment expense, and a minimum of labor. War Department trucks of the Maintenance Division of the State Highway Department were available for the hauling.

Experimental Section 2,400 Ft. Long

The Midwest Oil Company and the Bureau of Public Roads were asked to contribute 50% each to the construction of this pre-cast slab pavement. There were many Doubting Thomases as to the probable success of the undertaking, but the State Highway Superintendent, D. S. McCalman, finally got the approval of the Bureau of Public Roads for an experimental section 2,400 ft. long, the Bureau paying half the cost and the Midwest Oil Company the other half.

The state law of Wyoming provides that state highway construction work of more than $2,000 cost shall be done by contract. As there was plenty of work for contractors at high prices, great difficulty was experienced in letting a contract at reasonable prices on this proposed new type of pavement. However, in September, 1920, a contract was let by the Highway Commission to the Levy Construction Company, of Denver, Colo.

Design of the Slabs

Reinforced concrete slabs 6 ins x 8 ft. x 9 ft. with wire mesh and 8½-in. bars were designed by the State Highway Department and approved by the Bureau of Public Roads. Six different types of joints were planned, giving a trial section 400 ft. long for each type of joint. Type A joint consisted of a reverse curve, warped surface with radii of 9 ft. 10 ins. and 8 ft. 1 in. Type B was similar, but with the two curves of the warped surface having radii of 4 ft. 8 ins. and 6 ft. 5 ins. Type C joint was an ordinary right angle joint. Types D and E joints had a batter of 2 ft. 9 ins. and 1 ft. 9 ins., while Type F had four sets of interlocking U-bolts locked with a ⅝-in. rod. All joints to be sealed with a bituminous filler.

Slabs Laid in Sub-zero Weather

The pouring of the slabs did not start until October, and before the pouring was completed, in November, there was considerable freezing weather and temperatures as low as 12 above zero were recorded. While the work was handicapped by snow and cold weather, the aggregates and water were heated to prevent freezing.

The slabs were laid in December, during which month there were several snow storms and the thermometer went to 6 deg. below zero. Anyone who knows the Wyoming winter with its constant high winds, will realize that conditions for slab laying were far from ideal. This work was under the very close supervision of the State Highway Department and the hauling was done with the State Highway trucks by the Maintenance Division.

The loading and unloading apparatus consisted of 10-in I-beams for trolley tracks mounted on A-frames. Three-ton

trolleys with 3-ton Triplex chain hoists were used for raising and placing the slabs.

Cost

The cost of casting was high on account of the experimental nature of the work and the high overhead for the amount of pavement cast, as well as the cold weather conditions encountered. The cost per yd. would have been greatly reduced on a larger contract as the Levy Construction Company bid just twice as much per yard for casting a 2,400-ft. section as they bid for casting a two-mile section. The cost of preparing the subgrade was high because of frequent freezes, but as the soil where the pavement was laid was very sandy, no trouble from heaving was anticipated. The hauling cost, allowing $6.00 per day for depreciation on each truck, was 39 cts. per ton mile.

This 9-ft. slab pavement has been laid on one side of the center line of a 24-ft. roadway, so that another strip of the same width can be added on the other side of the road.

Early Impressions of Results Secured

At the time this article is written heavy truck traffic has been passing over this slab pavement for two weeks and the very excellent surface of the pavement does not yet show any sign of the displacement that some critics feared. The relative value of the different types of joints cannot at this time be determined, although apparently the interlocking joint is the least desirable.

While the real value of such a pavement on a heavy traffic road can only be determined after several years' trial, a service has been rendered to the engineering profession in demonstrating that a pre-cast slab pavement can be successfully built. In future years short stretches of soil requiring pavement on otherwise good gravel or dirt roads and roadways in desert stretches may be paved in this way.

HOW LAKE FOREST, ILL., MAINTAINED WATER-BOUND MACADAM PAVEMENTS, AND PUT THEM IN PERFECT CONDITION AT LOW COST

By Neil N. Campbell, City Engineer, Lake Forest, Illinois.

In the spring of 1917, Lake Forest found itself with many miles of water-bound macadam pavements which were literally in "rotten" condition. New pavements had been planned for several of the streets, but on account of the restrictions brought on by the World War, this program was impossible, so a plan of efficient maintenance, low in cost as to labor, material and money had to be evolved in order to keep the roads in passable condition.

Lake Forest, being situated between the Great Lakes Naval Training Station and Fort Sheridan, and all motor and team traffic between the Naval Station and Chicago having to pass over its streets, and on account of the urgent request made by the commandants at Fort Sheridan and Great Lakes, the city of Lake Forest felt itself obligated to put its roads in good condition so as to make heavy motor traffic possible and to do its share in winning the World War.

Financing the Resurfacing

The plan was a rather comprehensive one and the work was undertaken under the personal direction of the writer. It included practically every macadam pavement in the city.

Each street was carefully inspected and a detailed estimate of the cost of resurfacing made. The estimated cost was then apportioned between all the abutting property owners as to frontage, and an agreement blank attached thereto, showing the amount assessed against each property and a blank line for the signature of the property owner.

This estimate of cost, together with the agreement blank was then turned over to some resident—on the street—who undertook to see each property owner and obtain, if possible, his co-operation. In this manner the city was enabled to finance the resurfacing project, about 80% of the total cost being assumed by the abutting property owners, the balance being paid by the city out of the street and bridge fund.

Two Classes of Streets Resurfaced

The pavements to be resurfaced were divided into two classes:

(1) Pavements that were in such a bad state of repair that it was necessary to scarify the surfaces and add new stone in order to put the pavement in reasonably good condition.

(2) Pavements that were in such condition that they could be put in reasonably good repair by patching the holes.

Scarifying and Adding New Stone

The work undertaken on pavements of the first class was as follows:

(1) Thoroughly sweep the surface of the old pavements with a horse-drawn rotary broom and remove from the street all dirt, litter and foreign material.

(2) Scarify the entire surface of the old pavement to a depth of from 2 to 4 ins. using a gasoline tractor to furnish the motive power.

(3) Re-shape the old pavement with a horse-drawn road grader, being careful to mix as thoroughly as possible the coarse and fine material and to bring the pavement to as perfect a surface as possible.

(4) Add new broken limestone, ranging in size from 1¾ ins. to 2¼ ins., to a depth of from 2 to 3 ins. This layer of stone was spread by hand and the surface of the pavement brought to a true and uniform crown and grade.

(5) After a light rolling to key the stone together, sufficient limestone screenings to fill all the interstices between the stone was added and the entire pavement was flooded with water and rolled until the whole mass was thoroughly compacted and smooth.

(6) After the pavement had dried out the street was opened to traffic for a period of from one week to ten days.

(7) The surface of the pavement was then thoroughly swept by means of a horse-drawn rotary broom and all surplus screenings removed, leaving the surface slightly roughened with the coarse stone exposed on the surface.

(8) The pavement was then surfaced with an application of Tarvia "A" applied hot, under pressure, using from 0.4 to 0.5 gals. per sq. yd. of surface and the whole given a liberal coating of red granite chips, using approximately 1 cu. yd. of chips to 70 sq. yds. of surface, and thoroughly rolling it until the granite chips were firmly imbedded in the Tarvia and the entire surface smooth and hard.

The following is a copy of the Engineer's report showing the itemized cost of resurfacing a part of Sheridan Road:

Itemized Cost of Resurfacing Sheridan Road from Brushwood Road to Rosemary Road

Work Done: The road was first scarfied and reshaped. Thereupon we added 3 ins. of new stone and screenings, flooded and rolled same to a hard and even surface and treated the entire pavement with Tarvia "A" and red granite chips.

VIEWS OF RESURFACED MACADAM STREETS IN LAKE FOREST, ILL.
Left: Lake Road, North from Barberry Lane, Resurfaced in 1917. Right: Westminster East, North from Deerpath East, Resurfaced in 1918.

Itemized Cost Per Square Yard

Scarifying	$ .0112
Reshaping	.0072
3 ins. new stone and screenings	.1574
Tarvia Treatment .444 gal. per sq. yd.	.0577
Granite surface	.0622
Engineering and Superintendence	.0080
Total	.3037
Estimated cost per sq. yd.	.37
Balance	.0663

Itemized Cost: Totals

Scarifying	$ 40.06
Reshaping	25.59
148.76 cu. yds. stone at 1.45	215.70
86.72 cu. yds. screenings at 1.45	125.75
Labor on stone and screenings	199.17
Rolling (city roller)	26.00
1,599 gals. Tarvia "A" applied at 13c	207.87
53 cu. yds red granite chips at $2.35	124.55
Labor applying granite	99.66
Engineering and Superintendence	28.80
Total	$1,093.15
Total estimated cost	$1,332.00
Balance	$ 238.85
Total sq. yds. pavement surfaced	3,600

Patching Holes

The work undertaken on pavements of the second class was as follows:

(1) Thoroughly sweep the surface of the old pavement with a horse-drawn rotary broom and remove from the street all dirt, litter and foreign material.

(2) Repair all holes and bad depressions with new stone and Tarvia.

(3) Resurface the entire pavement with Tarvia "A," applied hot, under pressure, using from 0.4 to 0.5 gals. per sq. yd. of surface, and apply a liberal coating of red granite chips, using approximately 1 cu. yd. of chips to each 70 sq.

yds. of surface, and thoroughly rolling it until the granite chips were firmly imbedded in the Tarvia and the entire surface smooth and hard.

The following is a copy of the engineer's report showing the itemized cost of resurfacing a part of Lake Road:

Itemized Cost of Resurfacing Lake Road from Barberry Lane to Woodland Road

Work Done: The old surface was first thoroughly cleaned and patched and afterwards the entire pavement was surfaced with Tarvia "A" and red granite chips.

Itemized Cost Per Square Yard	
Cleaning and patching	$ .0239
Tarvia "A" treatment .439 gal. per sq. yd.	.0571
Red granite chips wearing surface	.0511
Engineering and Superintendence	.0071
Total	.1392
Estimated cost per sq. yd.	.12
Deficit	.0192

Totals Itemized Cost	
Cleaning and patching	$ 45.45
835 gals. Tarvia "A" applied at 13c	108.55
27 cu. yds. red granite chips at $2.35 per cu. yd.	63.45
Labor applying granite	33.88
Engineering and Superintendence	13.50
Total	$264 83
Total estimated cost	**$228.24**
Deficit	$ 36.69
Total sq. yds. pavement resurfaced	1.902

or less, per sq. yd., there is bound to be some weak spots caused either by their not receiving their full application of Tarvia, or on account of loose screenings or dust being left on the road surface. After one year's wear these weak spots are likely to show up, and by patching them with a little Tarvia and chips immediately preceding the second application, you are insured of obtaining a uniform surface that will withstand a great amount of heavy traffic.

Cost of Second Application of Surfacing Materials

The average cost of the second application of Tarvia "A" and red granite chips on a total yardage of 36,402 yds., applied in 1918, was 9.4 cts. per sq. yd. The Tarvia was applied at the rate of 0.27 gals. per sq. yd., and surfaced with red granite chips using 1 cu. yd. to each 70 sq. yds. of surface.

Results of Resurfacing

In all the resurfacing work great care was taken in the reshaping of the old macadam pavement and in patching the holes and depressions to bring the pavement to as near a true crown and grade as possible. Immediately preceding the application of the Tarvia the pavement

VIEWS OF MACADAM PAVEMENT IN LAKE FOREST, ILL.
Left: Barberry Lane, Showing Typical Condition of Macadam Pavements Before Resurfacing. Right: Sheridan Road, North from Westminster East, Resurfaced in 1917.

Excellent Results Secured

In all the work undertaken the engineer estimated, included in addition to the first or original resurfacing, a second application of Tarvia "A" and red granite chips to be applied the following year. This practice has given excellent results and the pavements so treated have stood up under very heavy traffic and are in perfect condition after practically four years' wear. In fact, during the war as many as 300 machines per hour, for a ten hour period, have passed over Sheridan Road (a pavement 18 ft. wide).

Our experience has been that where a new macadam surface is treated with such a small quantity of Tarvia as ½ gal., was carefully swept by a rotary horse-drawn broom and by hand brooms so that all dust and loose material was removed, insuring a good, hard, uniform, clean surface for the Tarvia to adhere to. The application of the Tarvia was carefully inspected and the quantity applied gaged to meet the requirements of the particular street being treated with the result that out of a total of 114,200 sq. yds. of pavement resurfaced during 1917, 1918 and 1919, there is only one short stretch of pavement that is not in first class condition. This section of pavement is located on Sheridan Road on a fairly steep grade and carries very heavy traffic, and although the surface has not broken,

it has shoved in places and is getting wavy. This pavement withstood two years of very heavy traffic during the war without showing any tendency to shove or get wavy, but during the third and fourth seasons wear has developed waves in places.

Why Waves Developed in One Place

There are two principal factors which enter into and are the chief causes of this condition. The first and perhaps the principal, is the tendency to skid the machine when the brakes are applied on the down grade, and the excessive traction of the power wheels in climbing the grade. The second is due to the fact that on the first application of Tarvia in the resurfacing of this section of pavement too much Tarvia (0.61 gals. per sq. yd.) was used with the result that we were unable to work in enough chips to take up all the Tarvia, leaving a surface carpet which became slightly plastic excessive traction of the power wheels caused it to shove and become wavy. Our experience has been that where the pavement surface is in good condition and the Tarvia applied skilfully by means of a mechanical pressure distributor that from 0.4 to 0.45 gals. per sq. yd gives the best results, care being taken to apply all the chips the Tarvia will take up, and thoroughly rolling it immediately after the chips are applied.

The work of resurfacing was handled by a very small force, the major part of the work being done with one team and four men, one of whom served as foreman. Extra teams were hired to haul the crushed limestone and granite chips. The Tarvia was purchased from the Barrett Company, who delivered and applied the hot Tarvia under pressure on the pavement, by means of their special auto truck service.

THE SAGITTA: A USEFUL BUT FORGOTTEN TRIGONOMETRICAL FUNCTION

To the Editor:

It is a far cry from the days when mankind used the bow and arrow as the principal weapon of defense to the present day when big guns are constructed, which will shoot a projectile 20 miles or more. Yet in those days, perhaps 800 or 1,000 years ago, the foundations were laid for the nomenclature which we use today in many of the sciences, particularly in the science of mathematics, which, of course, was much farther advanced than the other sciences of those early days. So far as our present records show the ancient mathematicians, who are supposed to have lived about 2,000 years ago, were already in possession of all the fundamental points in mathematics, and trigonometry especially. By analogy, there is every reason to believe that some of the most advanced mathematicians of today are also 2,000 years ahead of the rest of us mortals, or that it will take about that long before the theories now developed get any application in practical life.

The development of the various branches of mathematics is very unequal, however, and while the above remark applies to the science in general, there are some branches that are even at the present time far behind the requirements of their practical applications, and consequently compel us to use the so-called "rule-of-thumb" methods, simply because science has no answer or solution to the problem. One of these branches, for instance, is the "theory of conform representation," as practically applied to mapmaking.

As stated above, the names which we now use in trigonometry were probably created in the days when the bow and arrow were the most familiar objects to which mathematical lines could be compared. For instance, our word "arc" corresponds to the Latin word for "bow," and our word "chord" corresponds to the Latin word for "bow-string." Now the word "arrow" in Latin is called "sagitta," from which is derived the name of the constellation "Sagittarius," or "the archer"; and it seems certain that this name was originally given to some part of the radial line which bisects the arc. The name itself was commonly used from the earliest antiquity, of which we have any record, so far as the history of trigonometry is concerned, until perhaps 40 or 50 years ago, but seems to have been forgotten by our modern authors. Curiously enough, the available authorities differ widely in regard to the exact meaning of the word, that is, to what part of the above mentioned radial line it did apply originally.

The earliest mention of the word sagitta in connection with trigonometry of which we have any record seems to be in a book entitled: "The practice of "Geometry" (translated title) by Leonardo of Pisa, also known as Fibonacci. This book is supposed to have been written in the year 1220, and since this was before the invention of printing, it could only have

existed in manuscript form, and it probably was not printed until after 1500. The edition which we now have was printed in Rome in 1862. Now one of the historians of this subject claims that Leonardo has mixed up, or identified, the sagitta with the sinus versus.

On the other hand the "Century Dictionary," printed in 1889 to 1911, states under the word "Sagitta," definition No. 7: "In Geom...: (a) The versed sine of an arc, so-called by Kepler (1579-1630) because it makes a figure like an arrow upon a bow. (b) The abscissa of a curve. (Hutton)." Whether it was Kepler or Leonardo, or somebody else, who first mixed up these functions, it is reasonably certain that the mix-up is of an early date, because it occurs also in "Zedler's Universal Lexicon," printed in 1742.

In order to form an idea of the probabilities in this case, regardless of the "conflict of authorities," let us imagine one of the "long-bowmen," of olden times, holding his bow and arrow in a vertical plane, with the arrow resting lightly against the tensed bow-string, and pointing upward in a slanting direction, and comparing this mental picture, with a geometrical diagram or figure drawn on paper, consisting of a circular arc, with its central and terminal radii and terminal tangents. Remembering that the term "sinus versus arcus" or versed sine had probably long before been applied to designate the part of the central radius, between the arc and the chord, as referred to the half-arc, it seems natural to reserve the term "sagitta" or "the arrow" for the extension of the central radius between the arc and the meeting point of the terminal tangents, also as referred to the half-arc. It is difficult to see how or why any mathematician should confuse the line so defined, which is entirely outside the circle of which the arc in question is a part, with the versed sine, which is entirely inside the same circle. Some modern authors, like Raymond (1896) and Allen (1903) have renamed this line, and called it the "external secant."

By this time, no doubt, the question arises in the mind of the reader of these lines: "What has all this ancient history stuff got to do with us, who live in the enlightened twentieth century?" Simply this: by the study of the sagitta the present writer was led to develop a method whefeby a common slide-rule, or a 5-place, or a 7-place logarithm table will give 3, or 5, or 7 places, respectively, in every case, thus practically doubling the usefulness of these helps in calculations.

The complete mathematical demonstration is much too long and complicated for publication in an engineering journal addressed to men of widely varying interests, but I shall be glad to give information of value to computers who will drop me a line.

M. J. EICHHORN,
502 W. 60th Place, Chicago, Ill.
Jan. 31, 1921.

SEWAGE TANKS—AGAIN

By G. Everett Hill, Consulting Engineer, 45 Seventh Ave., New York, N. Y.

When Mr. Kirchoffer's paper, "Operating Experiences with Imhoff Sewage Tanks" appeared in Municipal and County Engineering of March, 1920, I read, and reread, it with great interest and appreciation because it crystallized in admirable form doubts and beliefs which had evolved from my own experience with digestion tanks of various types. The comments by other engineers, published in the September issue, and the renewed discussion of the subject in the January, 1921, number are likewise interesting; but I feel that one or two points of real significance have been overlooked or under emphasized, and these I desire to lay before the readers of Municipal and County Engineering, in the hope that they —and particularly Mr. Kirchoffer—may consider and criticize them.

Some Doubts About the Imhoff Tank.

When the Imhoff tank first appeared above the horizon to enlighten a benighted world, its effulgence was clouded by a large doubt which formed in my mental atmosphere. I did not believe that destruction of sewage sludge by biological processes could be complete and rapid in a shut-in sludge-chamber, where there was no flowing liquid to remove the autotoxins produced by the reducing organisms. There is a biological law—so wide reaching as to appear practically without exception—that decrees loss of energy or actual death to organisms that remain surrounded by the metabolic products of their own vital functions. The destruction of pathogenic germs with toxic products of like germs is daily routine work of the physician.

I confirmed this belief by experiment. I filled two glass containers with sewage and covered them with glass plates. The sludge which settled in the two was alike in quantity and quality. Characteristic putrefaction ensued, ran its course and

ceased. Anaerobic digestion was apparently complete; and no further change in character or volume could be detected during a period of four weeks. One of these containers remained untouched, as a check. Into the other a very gentle continuous flow of fresh filtered sewage was introduced, under conditions which produced no apparent mechanical disturbance of the sediment, but gradually displaced the supernatant liquor. *Activity within the sludge itself was resumed* and maintained for some days, resulting in *a further diminution of volume.*

Dr. Imhoff Quoted.

In an article published (in translation) in the Engineering Record of July 22, 1916, page 101—an article very pertinent to this discussion, but which has not yet been quoted, Dr. Imhoff himself admits:

(a) That in sludge where there is no moving water decomposition "will be relatively feeble."

(b) That it is "logical to feed the sludge that is properly decomposing," and that, to maintain efficiency, fresh sludge should be introduced and mixed with the older sludge.

(c) That this mixture must be thorough and intimate.

(d) That in separate sludge-decomposing chambers much coddling of bacteria is necessary; he even suggests stimulation by "warm water supplied from a central heating plant."

An Eminently Sensible Thing.

In introducing raw sewage directly into the sludge chamber, Mr. Kirchoffer has done more than the eminently sensible thing of putting the solids at once where we want them eventually. He has also passed moving water through this sludge chamber, and he thus removes, as fast as formed, the products of decay, which in the unmodified Imhoff tank paralyze the sludge-destroying agents.

Mr. Kirchoffer, in his last contribution, might be interpreted by some as insistent upon the accepted structural type of "two-storied" tank. The "hopper and slot" safeguard and the "upward flow" can be secured in a tank no deeper than the usual single-story sedimentation and digestion tank, as shown in the accompanying drawing. When construction lies in rock or in quicksand the cost of deep tanks is heart-breaking.

What a Single-Story Tank Accomplished

I know from experience that the single-story tank may be made to yield an efficiency not usually attributed to it. A tank of this type which I built at Wayne, Penna., put in commission September 26, 1907, ran without *any removal of sludge* until April, 1915. Throughout this time it served continuously an average of 3,200 people. The total solids it received in these seven years and seven months must have been about 1,200 tons. Of course, this was not all destroyed in the tank. Much of it escaped in comminuted form and was caught by coke-filled roughing filters before the sewage passed to the sand-beds; but neither roughing filters nor sand-beds were renewed in this period, —they simply received ordinary cleaning; and *two* sand-beds at a time, out of a total of eleven with a combined area of 2.11 acres, took the entire flow. The greatest mechanical removal of solids in this time averaged two and a half wheelbarrow loads a day (something less than 50 lbs.), raked from the sand-beds and from the sludge bed which received periodically the drainings from the roughing filters.

My experience in sewage treatment during the last 30 years seems to justify certain special features of single-story tank construction. Brief mention of them may be interesting.

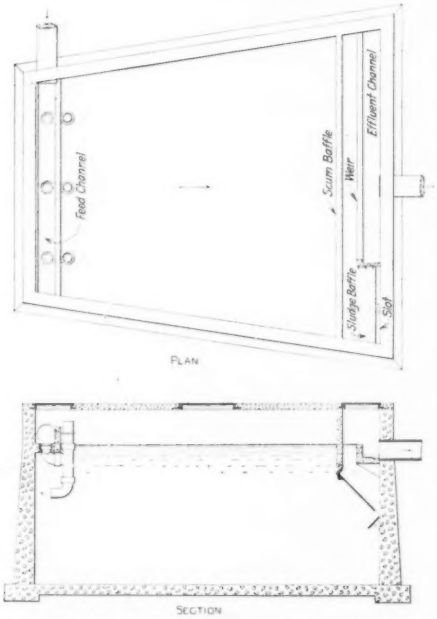
Special Features of Single-Story Tanks

I prefer to build each chamber with diverging side walls, with the inlet at the narrower and the outlet at the wider end. Prolonged tests of such a tank, side by side with one of equal capacity but with parallel walls, showed the average sedimentation efficiency of the rectangular tank to be but 82% that of the radial-walled tank. The reason seems obvious. At the wide outlet end of the flaring tank the velocity is markedly lower than the mean velocity, which is the constant velocity of the rectangular tank. Some solids that weigh little more than water, which would be carried indefinitely by the mean velocity, settle and remain in the tank; and masses of gas-buoyed sludge, rising near the outlet end, have a somewhat better chance to settle again before the outflow is reached.

Moreover, I have found that in the flaring tank there is a pronounced gain in digestive efficiency. The causes are obscure; but the phenomenon may perhaps be due to the elimination—or lessening—of bacterial antagonisms by the approximate segregation in different zones of the many different kinds of saprophytic bacteria, preferring different foods and finding them in the several classifications of solids, according to weight, caused by the sliding scale of velocities.

Dr. Schmeitzner, in his book "Clarification of Sewage," compares the efficiency of a tank at Sheffield, with parallel sides, and one at Viersen, with widening cross-section. He reports the removal effiicency of the former as 49.3% and of the latter as 82%. Mr. Fuller, in his "Sewage Disposal" (1912), also proves "a progressive increase in width of tank toward the outlet, so as to reduce the velocity of flow."

The effluent escapes over a smooth dead-level weir-wall (protected by scum-retaining and sludge-retaining baffles)



PLAN AND SECTION OF SINGLE STORY SEWAGE TANK OF UNUSUAL DESIGN.

that extends across the whole wide outlet end of the tank. Drawing equally from all points on this long line, the displacement within the tank itself is practically uniform from wall to wall. Moreover increase of velocity is very slight (until the weir is actually reached); and the thin film of water creeping over the weir is too shallow to float sludge masses, which stop when they hit the edge and crumble gradually into minute particles too small to see. I have found wire-glass, supported by angles or channels, admirable for baffiles. It also makes excellent hopper plates for small Imhoff tanks.

The best feed device I know is the reverting pipe inlet shown in the accompanying illustration. This is the result of a long series of experiments with inlets of various designs, at different depths, in a glass tank filled with clear water and fed with colored water containing solids of varying sizes and specific gravities. Three quarter-bends check initial velocity, and the last delivers, above the sludge and below the scum—not horizontally toward the outlet, where it would induce currents—not vertically where it would stir up deposits—but horizontally *against the rear-wall* of the tank, so that the liquid spreads at once and almost uniformly across the whole vertical cross-section of the inlet end of the tank before it begins its slow travel toward the outlet end. Thus maximum section of displacement and minimum velocity are secured. (A good idea of the diffusion accomplished may be gained by standing one foot from a vertical wall and blowing against it, at right angles, a gentle stream of cigar smoke.) In large tanks, inlets of this kind are in multiple, opening from a common feed channel.

BITUMINOUS FOUNDATIONS FOR PAVEMENTS

By Hugh W. Skidmore, of Chicago Paving Laboratory, Consulting and Inspecting Engineers, 160 N. Wells St., Chicago.

(Editor's Note: While considerable information on this topic has been published in recent months, Mr. Skidmore, in this paper, presented at the 1921 meeting of the Illinois Society of Engineers, has brought together data along lines largely untouched in previous discussions of this important subject.)

For a number of years past, the majority of engineers engaged in highway work in this country have thought in terms of rigid pavement foundations. Rigid foundations came into wide use for a number of reasons.

Highway engineering, as distinguished from civil engineering in general, is of recent development and consequently is lacking in much of the essential knowledge and refinement necessary to reduce the art of building pavements to any very great degree of exactness. Constant increase in volume and radical changes in the character of traffic have very naturally hampered progress. A wide variety of local conditions has prevented laying down any hard and fast rules.

Paving engineers have been confronted with the problem of meeting the demands of traffic under a variety of con-

ditions as presented by the rapid development of a new country; while at the same time attempting to carry forward such investigations, research and analysis as was required for even a fair knowledge of the many factors involved. Therefore, it is not surprising that we should still be correcting early mistakes.

Influence of Precedent

Inexperienced engineers in charge of the design and construction of pavements have of necessity turned to outside sources for their specifications and details of design, usually without sufficient time for investigating the suitability of type with respect to ultimate economy. This fact in conjunction with the very human tendency to follow in a given channel once started, may in a large measure explain not only the growth of the rigid pavement type irrespective of traffic requirements, and an almost universal disregard for adequate drainage and proper subgrade preparation; but likewise a rather general display of more or less hesitancy in giving serious consideration to the accomplishments of others thinking along different lines.

European engineers generally, and those of Great Britain and France especially, with the advantage of a much longer period of time in which to study pavement construction, and with governmental bureaus which are not subject to the interruption and upheaval due to a change of political complexion, such as we are accustomed to here, have paid particular attention to drainage and still maintain an extremely skeptical attitude towards rigid pavements.

History of Bituminous Base

For many years the use of bituminous foundations in the United States has continued uninterruptedly. The oldest examples are to be found in some of our Eastern cities; some of these pavements were laid more than forty years ago, and while the refinements of street pavement design during this period have necessitated both the removal and alteration of many of these old pavements, it is nevertheless a fact that even today some of the original foundations, either in whole or in part, may be found to exist. It has been said of "Black Base" in the city of Washington, that the trouble with the old pavements was not in the foundation, but rather that such defects as did occur were traceable to faulty composition of the wearing surface. The binding material has usually been found to be in an excellent state of preservation and gave every indication of offering several years of additional service, despite the fact that these old pavements were not laid under present day knowledge of the art and modern methods of scientific control.

Bituminous Base Much Used in the West

In more recent years the use of bituminous foundations has grown rapidly in the west until at the present time the yardage in California, Oregon and Washington alone runs well into the tens of millions. There are numerous examples of more limited yardages throughout the middle west. Examination of several of these pavements has revealed a variety of soil and drainage conditions; both hot mix and penetration methods of construction; various thicknesses of both base and top courses, ranging from a total pavement depth of 4 to 9 and 10 ins., depending upon the traffic and character of the subgrade; the employment of both sheet asphalt and bituminous concrete as a wearing surface; the use of all-gravel coarse aggregate, various kinds of crushed material, and a combination of gravel and crushed stone; and service records of from 1 to 20 years at the time of examination. None of the pavements examined gave any evidence of disintegration, internal movement, displacement or cracks, although in one or two cases there was some indication of subsidence over weak subgrade areas (it was planned to repair these by means of the well known "skin patch"), and it might be said of each case of this sort, that all of the trouble could have been readily avoided by better subdrainage.

It will not be the intention of this paper to indulge in an extensive technical discussion, as it is thought that recent articles in the technical press have presented in a most comprehensive manner the reasonableness of this type of construction from a theoretical standpoint. In this connection, however, for the purpose of reference, attention is particularly directed to an article by Lester Kirschbraun which appeared in the Engineering News-Record of June 21, 1917, and an article by Prevost Hubbard, appearing in Engineering News-Record of Dec. 30, 1920. On the other hand, the writer's thought in presenting this paper was first, to outline briefly the history of bituminous foundation construction for the purpose of showing that the type is not new or untried, but has been satisfactorily used for upwards of 40 years; second, to point out its practicability and economy,

and third, to briefly outline some of the more important features of construction.

Practicability

To engineers, who have had experience with various types of broken stone and macadam pavements and foundations, and who have laid wearing surfaces upon either new stone bases or have resurfaced old pavements, the use of either hot mix or penetration method bituminous foundations should appear as the logical step in the direction of progress and better construction. It would seem in this connection that experience over a period of many years should leave no doubt as to the advantages of flexible foundations such as Telford macadam, waterbound macadam, broken stone, gravel macadam, etc., over some of the inherent disadvantages of cement-concrete as it is usually laid for foundation purposes. The rigidity and resiliency of cement-concrete prevents uniform contact with a subgrade incapable of providing uniformity in supporting power, and as is a well known fact, cement-concrete does crack; often this will occur even when precautions are taken to provide underdrainage. The well-known affinity of cement-concrete for moisture results in a film of moisture at the contact plane between the foundation structure and the wearing surface. In the case of bituminous wearing surfaces, the almost constant presence of such a film of moisture on the surface of the foundation tends not only to disintegrate the bituminous structure, but also acts as a lubricant which in many cases is the direct cause of what is known as "pushing" or "rolling" of the asphaltic surface on concrete base. It may readily be seen that should the surface of the concrete happen to be somewhat smooth, any tendency of the wearing surface to become displaced under traffic will be greatly encouraged in the case of a well lubricated plane of contact.

It may be interesting to recount here an incident in the writer's personal experience which well illustrates the point just mentioned. A few years ago, while examining asphaltic concrete pavements in a certain city for the purpose of making a report to the city engineer and board of commissioners relative to the cause for certain sections of the pavement displacing under traffic, the writer made the statement to the local engineer that investigation would undoubtedly show that, first, the concrete base under these areas was extremely smooth, and, second, that even during the hottest summer weather (during which time the maximum displacement occurred) there would be a film of moisture on the surface of the concrete foundation. The city engineer took exception to the last remark, saying that the summer had been extremely dry, there having been no rain for a matter of some two months. Removal of the wearing surface for the purpose of replacing the mixture in the affected areas, proved conclusively that both of the writer's assertions were true.

LAYING 5-INCH ASPHALTIC CONCRETE BASE AT OWENSBORO, KY.

The results of certain impact tests on slabs and beams, as disclosed in Mr. Hubbard's article mentioned above, indicates not only the fact that bituminous

concrete considered as a slab or beam, provides very appreciable resistance to the most destructive of traffic forces, namely, impact, but that also in the light of these tests, it will be possible to use under similar subgrade and drainage conditions, a thinner base course of bituminous concrete than will be required of Portland cement-concrete. The conclusions which may safely be drawn from the tests thus far reported, place bituminous concrete foundations in even a more favorable light than might have been predicted by even its strongest advocates in the absence of such tests.

It is true that reasonably good drainage must be provided if real success is to be obtained from the use of bituminous mixtures for foundation purposes. In this regard bituminous concrete is in the same category with other types of foundation, as drainage is unquestionably the first essential to be considered in the case of any type of pavement if maximum utility and enocomy is to be considered worth while.

As an illustration of the economy of providing an adequately drained subgrade, Owensboro, Kentucky will be cited as an excellent example, not with the idea that this is the only example, but rather because the writer was particularly impressed with the excellent condition of the pavements in that city, which, without a doubt, is largely due to the fact that a 4-in. tile drain was laid under each curb at a distance of some 2½ ft. below the gutter. These drains in turn were connected with the sewers. The pavements in Owensboro are laid on practically all types of foundation including asphaltic concrete, cement concrete, waterbound macadam and gravel, and with the exception of one or two of the old sheet asphalt pavements, laid some 20 years ago, which show a few cracks due to the drying out of the wearing surface, there are to be found in some ten miles of pavements no cracks, upheavals, or other evidence of pavement disturbances. To digress while speaking of Owensboro, it is desirable also to mention that the city engineer, by careful study of his materials, has produced a bituminous concrete mixture both for foundation and wearing surface which employs washed Ohio River gravel and a combination of Ohio River sand and local pit sand, which develops unusual density and stability despite the fact that it has long been the theory that round particles in an asphaltic mixture would not make for the maximum of stability. It would, therefore, seem that density alone is a very important item so far as the resistance to the displacing effect of traffic is concerned.

Advantages

The advantages of bituminous concrete foundations can be enumerated briefly as follows:

1. Provides homogenity of mass and positive bond between foundation and wearing surface when bituminous top courses are employed.

2. Provides uniform contact with the subgrade, thus insuring the benefit structurally of all of the beam strength possessed by the foundation slab and by the same token, makes certain uniform distribution of load to the subgrade.

WHAT HAPPENS WHEN CEMENT-CONCRETE BREAKS OVER A WEAK SUBGRADE.

3. Because of the inherent flexibility of the material, the foundation slab will at no time be called upon to act as an arch over weak subgrade areas, therefore the possibility of the foundation rupturing, as is frequently the case with Portland cement-concrete, will be reduced to a minimum.

4. Provides freedom from cracks and upheavals.

5. Insures against the presence of moisture in the foundation structure, thus prolonging the life of the pavement.

6. May be easily repaired at minimum cost; the surface patch method being applicable except in the case of very serious defects.

7. Provides decided economies in construction as it disposes with the equipment and organization necessary to lay cement-concrete, thus affording the con-

tractor the advantage of exclusive use of that portion of his ordinary equipment and labor organization which in actual operation has heretofore proven to be the most economical and thereby profitable.

8. Does away with the long period of time required for curing of the foundation, thus permitting the opening of completed work to traffic immediately and providing a rapidity of turnover to the contractor not possible in the case of rigid foundations.

9. Permits the use of the same materials, except cement, as are employed in cement-concrete work.

10. Under similar conditions, using the same aggregate materials, bituminous concrete of equal thickness will be found to be cheaper than cement-concrete at present prices.

Economy

The opportunities for economy have been touched upon under "Advantages of Bituminous Foundations" just as enumerated. It is the opinion of contractors who have laid this type of foundation, as well as of those who would like to lay it, that a saving may be effected of from 35 cts. to $1 or more per sq. yd. Again citing as an actual example, Owensbore, Ky., a saving of better than $1 per sq. yd. was shown on the basis of 1917 prices, by the use of bituminous concrete as compared with the cost of cement-concrete of the same thickness and using identically the same aggregate materials. Inasmuch as contractors engaged in laying bituminous pavements seem to be agreed that that part of their organization necessary for laying cement-concrete has proven to be the least profitable, and that this class of labor has been the least efficient, and have expressed their confidence in the practicability and economy of bituminous concrete foundations as compared with cement-concrete, there should be no hesitancy on the part of the engineers in specifying this form of construction for fear that they will experience difficulty in receiving bids from contractors. Further opportunity for economy of construction is to be offered by the existence of many old pavements throughout the country which are in such a state of repair as to render them of questionable value even as foundations, yet many of them possess intrinsic worth considered in the light of an artificial subgrade which may be overlaid with coarse mixture bituminous concrete which in turn will be covered with a suitable wearing surface, thus giving a first-class pavement at even somewhat lower cost than has been above indicated, since in most such cases a thinner base course will be found ample.

The use of bituminous foundations is not necessarily restricted to bituminous surface types, but may also be used to equal advantage, although possibly with not quite as much relative economy, for brick, creosoted block and even granite block wearing surfaces.

Conclusion

In conclusion, the writer wishes to emphasize that there is nothing in the way of an insuperable mystery surrounding the construction of bituminous pavements. While it is true that careful attention to details of design and common sense in connection with the selection of materials and construction methods, are necessary, as well as intelligent and careful supervision and control of plant and street operations, these requirements are in no way peculiar to this type of construction and cannot be offered as an excuse for the adoption of some other type when a bituminous foundation would be found more satisfactory and economical. The employment of either penetration or hot mix type will call for no more precautions than are customary with stand-

BITUMINOUS BASE AND SHEET ASPHALT TOP IN PERFECT CONDITION AT AGE OF 19 YEARS, WHEN REMOVED AT HAMILTON, OHIO, UPON CONDEMNING STREET TO MAKE WAY FOR A FACTORY BUILDING. NOTE POSITIVE BOND BETWEEN BASE AND TOP.

ard construction, in fact, standard specifications for these types of pavements may readily be adapted to use in building a foundation.

The maximum size of coarse aggregate allowable will depend upon the thickness of the base course, but will not exceed 2½ ins. in its largest dimension, due to the desirability of laying the foundation in courses not to exceed 3 ins. in depth after rolling. For the hot mix type a mixture such as follows is suggested:

Asphaltic cement, 4 to 6%.
Sand, or fine aggregate passing a 10-mesh screen, 25 to 30%.
Coarse aggregate, 65 to 71%.

The sand considered alone will contain from 40 to 50% of particles passing a 40-mesh screen, and as to the combined aggregate, from 45 to 60% should pass a ½-in. screen, and not more than 35% should pass a 10-mesh screen.

In laying the foundation, it will be found necessary to thoroughly roll the hot material in order to insure maximum compression. For this purpose a heavy 3-wheeled roller will be found preferable to the tandem type, as these is less tendency for the roller to ride even slight elevations at the expense of proper compression in adjoining depressions; however, in laying the wearing course, tandem rollers will be needed in order to remove roller marks.

In constructing bituminous base pavements with bituminous wearing surface, it is possible to secure a smoother surface than is obtainable in the case of the same type of wearing surface laid on a rigid foundation, the reason being apparent from the use of two, three and even four layers, thereby reducing the tendency to duplicate surface irregularities in the subgrade through successive layers of thoroughly bonded, homogeneous material.

The thickness of either type of bituminous foundation will depend naturally upon traffic requirements, such local conditions as character and drainability of the soil, supporting power of the subgrade, and other items such as may arise which will require consideration in designing any type of pavement. The penetration type, however, will be limited to lighter traffic roadways, whereas the true concrete or hot mix type of sufficient depth, will be suitable for any traffic condition where bridging power is not the major consideration.

SEWAGE TREATMENT EXPERIMENTS AT GRAND RAPIDS WITH SPECIAL REFERENCE TO DORR SEWAGE CLARIFIER

By Milton P. Adams, Sanitary Engineer in Charge of Sewage Disposal Studies, City Hall, Grand Rapids, Mich.

The sewage treatment experimental work conducted at Grand Rapids, Mich., during the past 18 months has not covered the wide scope of experiments generally conducted in a sewage testing station. Rather, it has been an intensive operating study of a life-size sedimentation unit. The present article is in no way a technical treatise on sedimentation, but recounts merely the experience Grand Rapids has had, particularly in respect to the Dorr sewage clarifier.

The Grand Rapids Problem

Our problem is one in plain sedimentation and sludge disposal, our efforts being directed toward the meeting of a state supreme court injunction rendered in 1913. This decision called for the removal of the sludge forming materials in the city sewage before being discharged into the local watercourse.

The city is sewered on the combined plan and has a normal dry weather flow of 30 millions gals. of sewage per day.

Main Sewers

The sewage of the city is discharged into the river at present through four main interceptors, two on the west and two on the east side of the river. These were completed in 1911 as part of a flood protection program, there being an average annual rise and fall of 16 ft. in the river stage. A flood relief pumping station is located adjacent to the outfall of each trunk sewer. Gates, coarse bar screens, and low lift centrifugal pumps are provided in each station by means of which the levels in the respective sewers are kept below the danger point during this high water period. It is planned that the permanent disposal plant will be out of operation during this time, the sewage being pumped directly to the river as at present.

Sewage treated at the experimental station is typical of 75-80% of the total city flow and includes practically all the commercial and industrial as well as 9/10 of the domestic sewage of the east side. Thus it can be seen that the sewage has been as nearly representative of future conditions as could be obtained.

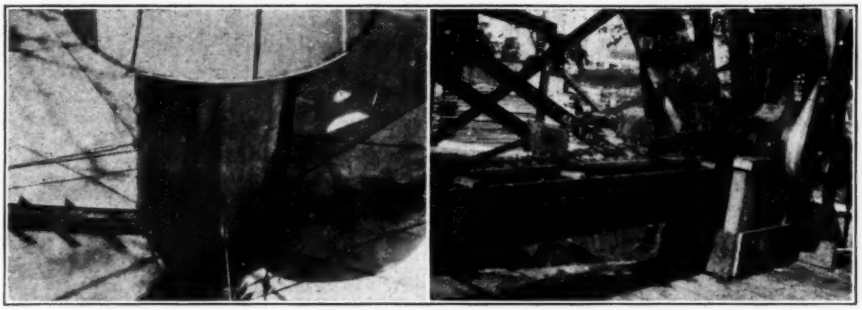
From June, 1919, to March, 1920, the

station was operated with the 32-ft. diameter tank as a Dortmund unit.

A Dorr Clarifier Installed

During April, 1920, a Dorr sewage clarifier was installed in the former Dortmund tank and operated until November last, when the station was closed down for the winter.

Sewage is delivered at the inlet trough of the primary tank by a 6-in. centrifugal pump belt driven from a 10 h.p. motor. Due to intake troubles, the rate of flow would occasionally fall to 0.2 million gals. per day. Our maximum rate was 1.1 and in the average day 0.6—0.8 million gals. of sewage were put through the primary tank. The flow was recorded hourly by the operator during the test day by reading the head over a standard rectangular V-notch weir placed in the effluent line from the tank.



VIEWS OF GRAND RAPIDS, MICHIGAN, SEWAGE TESTING STATION.
Left: Bottom of Sewage Inlet Jacket and Original Dorr Sludge Well. Right: Sludge Delivered to Horizontal Flight Conveyor.

Every effort was made to operate the station as a continuous day and night plant after Aug. 9, 1919. There was an operator in attendance at least 16 hours of each week day, and after the clarifier was installed, there was an operator in attendance constantly. In addition to the hourly flow readings, the operator made hourly settling solids and turbidity determinations on both crude sewage and effluent. Every third day, constant amounts from the hourly samplings were kept to form a composite of the day's run.

All samples and composites of sewage and sludge have been analyzed at the city laboratory located in the local filtration plant. This division of the work has been under the direct supervision of Chief Chemist Walter A. Sperry.

As the result of our experiments with the Dortmund tank, we determined that 57 deg. was very close to the limiting slope which could be used and not allow lodgment of the sludge on the tank bottom. The 45 deg.-slope was never satisfactory even with squeegeeing to bring the sludge to the tank pump.

If for any reason sludge was allowed to accumulate, or was held in the Dortmund tank for more than ten days in warm weather, "tank boiling" invariably occurred. Masses of sludge varying in size from a teacup to a dish pan would be buoyed upward through the tank by entrained gas. They would suddenly appear at the tank surface, the gas would be released, the sludge mass break up—a part settling back into the tank and a part passing out over the weirs with the effluent. At times the action became very general over the surface of the tank. At these times the effluent and tank efficiency suffered severely. But the drawing of sludge would generally relieve this situation.

Sludge Troubles

Considerable difficulty was occasionally encountered in starting a movement of sludge from the Dortmund tank. Backflushing with city water pressure through the sludge outlet into the tank was resorted to. This clogging or sticking of the sludge in the outlet was not due to the character of the sludge alone, but to structural limitations of the outlet itself and occasionally to lodgment of foreign material in the outlet.

During the normal operating day the surface of the tank was clear at all times and presented a good appearance with practically no odor whatever.

During the nine months' operation of the Dortmund tank a total of 105 million gallons of sewage were treated with an average removal of 45% of the suspended solids. Five hundred and eighty-three cubic yards of sludge were produced in the primary tank of an estimated average moisture of 93.5%.

The second set of sedimentation experi-

ments starting in May, 1920, were carried on with a 32-ft. Dorr sewage clarifier installed in the primary tank.

Nearly three carloads of cinders were required to fill the sump of the original tank, over which a 5-in. concrete slab was laid having the Dorr standard 1¾-in. on 12-in. slope toward the center. The central sewage depth of the new tank was now a little over 14 ft. with a depth at the periphery of the tank of 12 ft.

Description of the Dorr Apparatus

The Dorr apparatus can be briefly described as consisting of a centrally located vertical shaft to the bottom of which is keyed a 4-way spider to which radial arms are attached conforming to the slope of the tank bottom. A series of parallel squeegees are set at an angle of 45 deg. with the line of each arm. These are so adjusted as to just brush the tank bottom when the mechanism is rotated. The entire mechanism is suspended from a superstructure which bridges the tank. The driving of the mechanism is accomplished by means of worm and gear. The speed of our installation was 3/50 R.P.M., and driven by a 2 h.p. motor.

A watertight cylindrical wall of sheet steel, 4 ft. in diameter was fastened to, and supported by the four arms. It was symmetrically located with respect to the central shaft and turned as a unit with it. This original sludge well furnished by the Dorr Company had a clearance of 5 to 6 ins. from the tank bottom and extended to a point about 12 ins. above the sewage surface in the tank. The rotation of the arms was designed to roll the sludge over and over coming in the path of the squeegees, and finally bring it within the central sludge well.

A circular, galvanized iron jacket surrounding the sludge well received the incoming raw sewage from the surface inlet trough. By means of a throat in the jacket converging to within 2 ins. of the sludge well, a uniform distribution of sewage was obtained into the tank. The jacket was stationary and hung from the superstructure. It was 6 ft. in diameter at the top and 6 ft. deep, releasing the sewage in the tank 5 ft. below the sewage surface. The effluent was drawn off by a series of V-notch weirs set around the periphery of the tank. Thus so far as sedimentation goes we had a remodeled Dortmund tank.

Operations Commenced

Operation was commenced May 15, 1920. First sludge appeared in the well on June 1st, and on the 2d, 16 cu. ft. of 92.6% moisture sludge was removed from the well. Sludge was pumped every 2 or 3 days until the middle of June, when it became so concentrated that the pump would not handle it. The pump was a 2-in. diaphragm type furnished by the Dorr Company. Enough liquor was removed from the well during this period to allow it to re-fill with sludge.

We wired the Dorr Company for help on the 9th, stating that the situation was getting beyond the control of our equipment, and within a few days they had an engineer on the job who, jointly with the speaker, devised and built a mechanical sludge conveyor system. The conveyor was driven from the same countershaft which drove the clarifier.

With this apparatus, sludge was removed from the surface of the well by a chain of quart buckets, elevating to a tray, from which the sludge slid into a horizontal flight conveyor running in a wood trough. As the sludge approached the end of the trough, it dropped down an almost vertical chute into a loading hopper. Wheelbarrows were loaded with this sludge, and wheeled to the beds, where it was spread out to dry. The wheelbarrows were calibrated so that the amount of sludge removed from the tank could be recorded in this way. During a period of ten days in June, there was no movement of sludge into the well, that portion of sludge at the bottom and around the entry to the well took an "initial set," to use the concrete engineer's term, or concentrated to such an extent, that after the conveyor was put into operation, about 40 cu. ft. of sludge were all that could be withdrawn. The black, sulphurous smelling liquor remaining in the well could not be removed fast enough to force more sludge in.

Pumping of sewage was accordingly stopped and the tank was drained the first of July. After removing most of the sludge on the tank bottom it was discovered that an "island of sludge" had formed about the well which had been rotating as a unit with the mechanism. The entry to the sludge well was practically plugged.

During May and June, 24 million gallons of sewage were passed through the tank with an average removal of suspended solids of 30% corresponding to an indicated removal by settling solids determinations of 94%. A total of 1,900 cu. ft. of sludge were produced with an estimated average moisture of 87.8%. Of this amount 370 cu. ft. of an average of

90.2% were actually removed at the surface by pump or conveyor.

In fairness to the Dorr clarifier as a sedimentation device, it must be admitted that sludge development and not sedimentation was the object sought during the entire 6 months' run. As a result there are but few periods when the tank had a chance to show what it could really accomplish. The normal week day tank efficiency under fair conditions of operation showed a percent removal of 45 to 50%.

The lowest tank efficiency generally occurred on Sunday when the suspended solids in the crude sewage would fall below those in the effluent for more than half of the day.

Flaring the Well at the Bottom

Mr. Peck, of the Dorr Company, visited the experiment station about the middle of July, having been previously notified of the predicament the sludge had caused in the sludge well.

He conceived the idea of flaring out the well at the bottom, which was intended to overcome our difficulty and accomplish the following ends:

1. Increasing the area of sludge opening into the well by making the opening equivalent in length to the circumference of a larger circle.

2. The storage and covering of a greater volume of sludge within the well would make for better conditions in the outer sedimentation compartment, as well as to give greater flexibility in handling of the sludge.

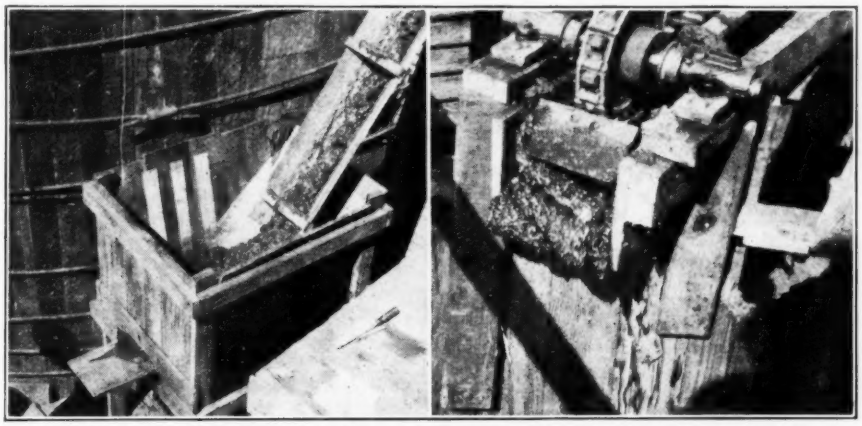
3. The concentration of as much evolved gas as possible within the well. The beneficial action of the gas in the 4-ft. well had already been noted both from its buoyant effects on the sludge as well as the drying power it had exerted in passing through the upper layers of sludge.

The "Grand Rapids" Sludge Well

Accordingly, the so-called "Grand Rapids" sludge well was constructed—a truncated cone of galvanized iron 10½ ft. high with a bottom diameter of 11 ft. and an upper diameter of 4 ft.

Provision was made at the upper diameter to attach one 4-ft. length of the 4-ft. well, bringing the upper rim of the composite well about 18 ins. above the tank surface. The change increased the sludge well storage from 1,400 to 5,000 gals., and increased the area of sludge opening from 5 ins. x 12½ ft. to 9 ins. x 34½ ft.

Operation was resumed the 30th of July and continued with but two or three shutdowns until the 21st of November. The first sludge was removed from the well on Aug. 24th, and amounted to 47 cu. ft. of 67.5% sludge. This was scum sludge, removed for the most part above the water surface in the tank, and was the dryest that we had obtained. All of the surface sludge had been removed by the 31st, several feet of black sludge liquor now appearing at the top of the well. This liquor was removed by a 4-in. Goulds diaphragm pump delivering 30-35 gals. per minute, and returned to the incoming sewage. About 4,500 gals. of liquor were removed from the well at this pumping, which allowed the well to completely fill with sludge from the tank bottom. Havoc was generally played with the tank effluent when this liquor or soft sludge was returned to the sewage inlet.



VIEWS OF SLUDGE HANDLED AT GRAND RAPIDS TESTING STATION.
Left: Sludge Entering Loading Hopper from Which it Was Wheeled to Beds.
Right: Character of Sludge with 80 Percent Moisture.

The effluent cones would be darker than the raw sewage cones for several hours. The suspended solids and turbidities also ran much higher at those times than in the raw sewage, although the settling solids readings were not appreciably affected.

The station was closed the last of November, the primary tank being entirely open and exposed to the elements. The approaching cold weather also made the handling of the sludge at the surface with mechanical apparatus next to impossible. For a week or ten days immediately preceding the shutdown, vain efforts were made to fill the well with sludge. Several thousand gallons of liquor were pumped out of the well, but it was found by soundings that there was hardly sufficient sludge in the tank to trap the bottom of the well. Hence, it could not be expected that the well would fill with sludge.

Plans for Future Tests

It is tentatively planned to reopen the station in the spring applying the clarifier to a still shallower tank, reduce the sludge opening into the present well, and develop an underflow sludge delivery from the bottom of the tank. The sewage and liquor inlet to the tank will also be revised.

Performance of the Clarifier

During August and September, the clarifier treated 18.5 million gallons of sewage with an average removal of suspended solids of 50%. During the last two months of operation this figure fell to 24%. From August to November 48.2 million gallons of sewage were treated in the Dorr clarifier; 2,311 cu. ft. of sludge averaging 83.2% moisture were produced. Of this amount 933 cu. ft. of 79.2% sludge were actually removed by conveyor, the balance remaining in the tank at the end of the run.

"Pin-Point Boiling"

In commenting on special features of operation of the clarifier, probably that, which for lack of a better term, we have called "pin-point boiling" is the most interesting. The surface of the tank in operation represents any quiet body of water over which fine particles of sand are being sprinkled. This is caused by the bursting of minute gas bubbles at the surface. This gas is evolved in the sludge on the tank bottom and released by the periodical moving of squeegee arms through the sludge.

This is not our theory, but has been proven to be a fact, for on shutting down the mechanism in warm weather, this "pin-point boiling" stops altogether—the tank surface is clear for 8 to 10 hours while gas is collecting and being retained in the sludge below. Finally, enough gas is entrained to buoy masses of sludge to the surface where it is released—the action being identical with "tank-boiling" experienced in the former Dortmund tank. On shutting down for a few days in June, a 6-in. leathery scum of sludge formed over the tank surface in 24 hours. Thus, the necessity of the operation of some kind of agitator in a tank of the type in promoting good sedimentation is clearly evident.

Effect of Baffling

Tiny globules of oil generally accompany these fine gas bubbles to the surface. It is this iridescent coloring of oil on water, which constitutes the only visible effects of this action. One half of the tank was baffled during the last three months of operation, the oil being caught just before passing out over the outlet weirs. As a result the effluent from this half of the tank was greatly improved although the appearance of the baffled half of the tank was accordingly sacrificed by the collection of the thin layer of scum retained upon it. It could not be proved that this "pin-point boiling" decreased the efficiency of sedimentation.

Sludge Characteristics

The 80% sludge produced during 1920 was a fairly stiff semi-solid and dried much less readily on the beds than the 94% sludge of 1919.

The original Dortmund tank went into operation June 30, 1919. On July 25th, the first sludge was drawn from the tank through its sump outlet and delivered to a secondary tank.

Its tarry odor, brownish-black color, and curdy consistence, as we have since come to know them, were at once evident. Moisture determination ran 94%. On the 7th of August about 300 gals. of this sludge were allowed to run directly to the sludge beds from the primary tank. Eighteen days later, this same sludge was removed from the beds in pieces—a matted, porous, fibrous cake. After a few days' further drying, this sludge was burned in piles on the dike surrounding the beds. A fluffy, reddish ash was left behind. This performance was duplicated many times during the summer and early fall with the same favorable results. Contrary to the behavior of most sludges which fissure vertically in drying, this sludge seemed to dry in layers,

separating laterally. Visitors at the station often compare the appearance of this sludge to that of heavy brown paper.

Secondary Tank Digestion Dispensed With

This very unusual behavior of a practically raw sewage sludge drying on sand beds under all sorts of weather conditions without nuisance or even appreciable odor, caused us to dispense entirely with secondary tank digestion during the past year. But two of the 20-ft. diameter sludge digestion tanks were ever used for this purpose. They were operated on the fill and draw principle. The same difficulty attended the drawing of sludge from the tanks as was experienced at times with the primary tank. Since there was so little to be gained by the use of secondary tanks they were abandoned with the idea that we would operate the station under the hardest conceivable conditions by drying a primary tank sludge on the sand beds and kick up a nuisance if possible! Well, we failed Another case in point of where the engineer is given an inch, he'll take a mile!

In addition to the many hundred gallons of sludge dried on the beds, thousands of gallons have been pumped from the tank at times of shut down, and allowed to drain to a low point 150 ft. south of the station, forming a lagoon. Visitors have never noticed the presence of this lagoon by reason of odors emanating from it.

Explanation of Inoffensive Sludge

Since we had precisely the same sludge experience during the past season that we had in 1919, and one that differs so radically from that in other cities, we have attempted to explain the mystery by a combination of circumstances.

First, we have a sewage that is comparatively dilute, amounting to more than twice the average water consumption. Thus the medium is provided by which many of the finely divided organic solids can be carried off in the effluent.

Secondly, the presence of tarry oils has always been noticed in the sludge. These are discharged in alleged small amounts by the local gas works. The antiseptic action of these light oils has long been recognized.

Thirdly, a large proportion of the sludge is made up of pulpy wastes, discharged into the sewer by a local paper mill. This material is practically inert and forms the fibrous mat which facilitates the drying and burning of the sludge. Samples of this dry sludge had a heat value of 7,000 B. T. U.

The ability of the sludge to "set up" when it is not periodically agitated was again manifested about the first of October, 1920. Instead of forming at the bottom of the well as before, several yards of the sludge formed a huge plug within the flare well, which threatened to put us out of business for a short time. Probing rods, long handled shovels, and 1½-in. pipes lashed to the superstructure and extending down into the sludge well were used from the surface of the tank in an effort to break up the plug, but without success.

It was broken up only after decanting off the upper 10 ft. of sewage in the tank, which allowed the plug to drop down within the well where it had a tendency to flatten out, spreading over the tank bottom. A 1¼-in. hose stream now helped in breaking up the mass. On refilling the tank with sewage, the plug came up again but much smaller in size. This was repeated three times before the plug entirely disappeared. After being broken up this sludge would appear in chunks rather than reverting to the homogeneous, viscous fluid from which it formed.

Conclusion

In concluding, it must be admitted that from the Grand Rapids standpoint with a sludge promising so little difficulty to handle, the high concentration is very desirable, especially where an almost unlimited space for sludge beds can be provided. There are 130 acres in the tract selected for the site of the permanent plant—fairly well isolated from the city.

There are several points still to be settled before final recommendations can be made. While much depends on the results of next season's experiments, the Dorr clarifier, in the opinion of the speaker, has great possibilities. Compared with the Dortmund tank it has given practically the same sedimentation efficiency, and delivered much more concentrated sludge for at least six months in the year with but half the excavation required for the Dortmund. A strong point for the clarifier is the emulsifying and concentrating effect imparted to the sludge by the rotation of the mechanism. Over against these advantages are the greater depreciation in Dorr superstructure and mechanism and the greater expert attention required for the successful operation of a plant of this type.

It is difficult, however, to imagine a plant the size of the future Grand Rapids plant, without a competent operating personnel. Inasmuch as the day is passing when engineers claimed great results

for plants that operated themselves, possibly the last disadvantage cited is not as great as it seems.

The city has expended $63,000 to date for sewage disposal purposes, of which $30,000 has been applied toward the purchase of land for the permanent site; $13,000 represents the city's investment in building and equipment of the sewage testing station, and the balance covers operation and other expense incidental to sewage disposal studies since April, 1917.

Messrs. Hoad & Decker, of Ann Arbor, were the designers of the original Dortmund tank and testing station. During the past six months the Dorr Company organization has taken an active interest and co-operated greatly with the city in conducting its experiments.

The foregoing discussion is the major portion of a paper by Mr. Adams before the 1921 meeting of the Illinois Engineering Society.

USING ASPHALTIC CONCRETE FOR RESURFACING WORN OUT PAVEMENTS

By W. E. Baldry, City Engineer, City Hall, Topeka, Kans.

(Editor's Note:—Pavements of different types have been laid in the large cities of Kansas since about 1895. Most of the pavements laid between 1895 and 1910 were either brick or cobble stone, with some sheet asphalt. The use of asphaltic concrete as a resurfacing material for pavements which have become unsuitable for present-day traffic is discussed in the following paper which was presented by Mr. Baldry before the recent annual meeting of the Kansas Engineering Society.)

The Cobble Stone Pavements

A general practice in the laying of cobble stone paving was to prepare the subgrade to the cross-section desired, and after spreading 2 or 3 ins. of sand, begin the laying of the cobble stones. These stones were of variable widths and depths and were laid with no particular care to secure smooth surface as we now consider it, but were finished with a roller drawn by teams or possibly power, and closed with a sand filler. These pavements have probably served their purpose very well, for as a general thing they have supported the traffic upon them and given a good foothold for the horses drawing heavy loads over them; they have also been capable of a fair degree of cleanliness. Under the years of traffic, however, these pavements have tended to become more rough rather than smoother, and the joints between the stones being large, there has been a tendency for the filling material to wash away, especially when laid upon any grade, with the result that today such pavements are good for but one thing, and that is to keep traffic out of the mud. These pavements have, under the action of traffic, become firmly bedded into the subgrade, and even present truck traffic does not show appreciable movement of the blocks, though the tractive effort necessary to overcome the irregularities of surface is considerable, and the desire of the traveling public at present is that these pavements shall be restored to a smooth surface, more than that they shall be replaced altogether. The problem, then, becomes the selection of a surfacing material, using the present pavement as a foundation or base.

Early Brick Pavements

The general practice in the laying of brick pavements in the early days was by what is known as two-course work, using a sand filler. In this work, after the preparation of the subgrade, a sand layer of 1 or 2 ins. was spread, and upon this was laid a course of brick flatwise. This first course was usually of what were known as No. 2 bricks, being from the sides and ends of the kilns. Over this first course was spread another layer of sand of from 2 to 3 ins., and upon this a layer of No. 1 bricks on edge were placed, over which was again spread sand and the whole rolled with team, hand or power rollers. This type of paving was at once far more sightly than the cobble stone paving, was reasonably smooth, and met the conditions of traffic in the residence districts especially well, but did not support the heavy traffic as well as the cobble stone paving. With time the filler material was washed away, the same as with the cobble stone paving, and the action of traffic chipped the bricks some, which, by the way, were not as hard and tough as our present good paving brick, until now the pavements have become worn and rough, though still passable. The lower courses have become bedded in the subgrade, in some instances to a solid foundation, while in other cases present traffic has cut through both courses and piled the pavement into crests and troughs, or pot holes.

Repaving Problems

It is the purpose of this paper to present a method of returning pavements of the types above mentioned to

usefulness under the present day traffic. There are several considerations in looking upon this problem: First, many of these cities have no legal means of compelling the re-pavement of these streets. Our state laws at present give ample means for securing new paving, but little or no recourse for the compelling of the repavement of streets unless a petition is received from the property liable for the cost of the work. In many cities conditions have changed, business has moved from where it was some years ago, property values have fallen, and the streets are left in a general state of bad repair and in some cases well nigh impassable. The city authorities may desire to place these streets in a creditable condition, yet they are unable to unless at the expense of the city at large. Some cities have decided to spend a part of their street maintenance funds to accomplish these ends, which is to make as much mileage passable as possible rather than as much yardage as possible.

A second consideration of this problem is that much of this early type of paving was laid with excessive crowning of the streets, which practice is not in keeping with the necessities of today. A means of cutting out some of this excess crown is very desirable in the consideration of the repaving of the streets.

A third consideration of the problem is the using of just as much of the present paving as can be done without harm to the new work, thereby cutting down the cost and perhaps hastening the completion of the work.

It is believed that the use of bituminous materials for the restoration of these pavements to meet the requirements of present day traffic is of sufficient merit to warrant a presentation of some methods of proceedure.

Bituminous Resurfacing Methods

In general, there are two methods of accomplishing desirable results in the study of this problem. Briefly, one method is to lay strips of additional material over the worn brick paving of such widths as to accommodate traffic, placing it down the center of the street, leaving the sides of the pavement for a distance of some 6, 8 or 10 ft. out from the curbing which is usually in much better shape than the center, undisturbed. On streets without street car tracks, it will be found that a strip of 16 ft. widths will meet the requirements very nicely, and on streets with car tracks, a strip of about 8 ft. in width on each side of the track will be found to take care of the traffic. In passing, it is suggested that where these strips are laid on streets with car tracks, the side of the strip next to the car track should be at least 3 ft. from the rail. This scheme might properly be called a temporary one, as it cannot possibly give the service as supplied by the second method.

A WORN-OUT PAVEMENT ON TOPEKA AVE., TOPEKA, KANS., AFTER FULL RESURFACING WITH TEXACO ASPHALTIC CONCRETE.
Street Resurfaced in 1917, Photograph Taken Jan. 11, 1921.

The second method carries with it the covering of the entire pavement from curb to curb, the building of new concrete gutters to create shoulders to which to tie the new paving, and the correction of such irregularities of the old paving as shall be necessary to present a first-class job when finished.

Strip Paving

To consider the first suggested method, that of applying only a strip down the main traveled portion of a street, there are two types of construction to be considered. One method is to prepare the old paving as will be given later under the

second method, and to apply the new wearing surface without any protection of the edges.

When this is done the edge will have to be tapered off in order that traffic may successfully turn on and off of these strips when passing other vehicles. In doing this, the tapering must be done short and sharp. In some of the earlier work this tapering was done in a distance of about 18 ins., gradually feathering out the edge to a knife edge. Experience has shown that here is where the first failure will take place for the new wearing surface has not the thickness to withstand the traffic, especially heavy hauling with iron tires. The practice of one engineer now is to make this taper at an angle of about 45 deg., it being considered that the inconvenience to the traffic is less than the damage to the strips, where a long taper is made.

Another method, and a better one, we believe, to employ where it has been decided to lay strips rather than to cover the entire surface of the old paving, is to take out the top course of brick along the edge of the proposed strip, and to construct here a concrete shoulder which shall have a vertical edge of at least 2 ins. on the strip side, and be tapered off as desired to the level of the old brick paving on the curb side. Such a construction will guarantee the position of the strip and require it to wear out rather than ravel out, but attention will have to be paid in this type of construction to these headers, that they may be able to withstand the tearing action of the wheels as they shall mount the strips from their position on the old brick paving.

Consider a strip laid, say 8 ft. wide along car tracks. Coal wagons, with a 4-in. iron tire loaded with four tons of coal passing over this strip will concentrate over an area of about 15 ins. width with each wheel, and there will be no variation from this track to amount to much. This coal haul will be probably heaviest in the summer season. If now the strip has been laid without headers, the tendency of this traffic will be to cause a slow flowing of the strip material eventually causing a cutting through of the same, after which the strip is of little more value than the original rough pavement. If now a header is provided, this may be overcome and the strip made to wear its allotted time. One may observe in Topeka many blocks of this strip work, and down in the bottoms where the heavy coal hauls are made to the western part of the city one may see where this traffic has sheared off these strips, leaving the center of the strip in good condition. However, proper care and watchfulness may be exercised and as these worn places appear, they may be repaired, and this maintenance may compare favorably with the cost of building headers, but it is desired to call attention to what may be expected rather than to analyze cost data.

The laying of strips of such widths as funds will permit without headers may be done in such a way as will pay in comfort and ease of operation for the traveling public, and where a city has worn pavements which it is unable to repave through lack of a petition from the property owners, the city is justified in spending its street funds to lay these strips over these worn pavements, and it is well to call engineers' attention to this possibility of reconstruction rather than for a city to put up with a condition over which it has no control. The city may hear criticism that in laying these strips at the general expense of the city, it is granting special benefits to the property abutting upon such improvements, and it undoubtedly is, but under conditions as above stated, it is justified.

Resurfacing Full Width of Old Pavement.

If now petitions can be secured for the resurfacing of a worn pavement from curb to curb, we offer the following method of procedure, which has in mind the permanent reconstruction of the street. This is our second method of construction and should be employed where a first-class job is desired.

The first matter for consideration in adopting this method of resurfacing is to look to the curbs or gutters.

It will often be found that where this older type of paving was laid, sandstone curbs were built and the paving extended to the curbs, also it will be found at times that cobble stone gutters were laid with brick paving. Under this condition the cobble stone gutters should be removed, and the curbing left in place if desired, or a new combination curb and gutter built. The old flow line of the gutter should be held, but the outer edge of the new gutter next to the paving, should be elevated so as to form a shoulder at least 2 ins. above the old paving, thereby providing for a 2-inch new wearing surface at this point. By making these new gutters of 24 or 30-in. width, this additional 2-inch pitch in the gutter will not be found to be harmful. If there is already in place a combination curb and gutter which it is not desired to disturb, the old paving next to the concrete gutter may be

removed and a strip of additional gutter built which will form the desired shoulder for the new wearing surface; this will probably make the gutter somewhat wider than common practice, but it need not be detrimental to the life of the improvement if carefully done, and be much cheaper than the removal of the present curb and gutter and the construction of a new combination curb and gutter which would provide the same advantages.

Leveling Off Old Pavement

After the construction of the new gutter is completed, a gang should start up the street again, taking care of all the potholes, ridges or sunken places, requiring especial attention. In doing this work, care should be used not to disturb any of the bottom courses of the paving. In two course brick paving the top course may be removed and readjusted if need be, but the bottom course should not be disturbed. If the bottom course has to be disturbed, a regular concrete base should be provided, and brought up to the grade of the wearing surface without binder course.

In this connection, attention might profitably be called to the tieing in of an improvement of this kind with adjoining streets already paved. Where two-course brick paving is being covered, the upper course is removed, and the 4-in. space provided is filled with 2 ins. of binder material and 2 ins. of new wearing surface, making a smooth junction with the adjoining pavements. Where cobble stone paving is being covered, the stones must be removed and concrete base put in to proper grade, or the adjoining paving raised to the new level, whichever is the cheapest accomplished. General depression should not be disturbed, but should be built up with binder material to the new grade, less the thickness of the wearing surface. Where the old pavement has been piled into ridges, or corn rows, a heavy tandem roller might be used to good effect to re-establish conditions, but if the ridges are firm, though uneven, it is best to leave them alone and to build up the quarters so that they may be properly covered with the new paving. In working out a job of this kind, it will be found that careful watching of the progress of the work, and the ability of the engineer to see how the finished product will look, is essential to success.

Making Ready for Binder Coat

The next step after leveling off of the old paving is the preparation of it for the reception of the binder coat. The first thing is the thorough sweeping of the street with a wire broom, removing all loose material on the surface, but making no effort to remove all of the old sand filler material. It might be well to call attention to one pertinent fact essential to the wearing qualities of the new paving; that is, in brooming the old paving, enough of the old sand filler material should be removed to give the asphaltic concrete a good grip upon the old paving, for this old paving is smooth, and without this clinch, the new paving will have nothing to hold it in place. In general the old filler material should be swept away until there is about ½ in. of it removed from the pavement surface.

After the sweeping, the next step is to apply a thin coating over this old paving to settle the dust and prepare for the reception of the binder coat. For this work a barrel, a good stirring stick and some common watering pots are brought upon the work. Asphalt of about 54 penetration is heated to a liquid state, and to this is added domestic distillate in the proportion of about 40% distillate and 60% asphalt, the ratio being varied somewhat with the weather conditions. With dry hot weather, the above ratio will make a good workable combination, the distillate will evaporate in about 24 hours, leaving the asphalt. After this mixing of the asphalt and distillate, the liquid is poured into the sprinklers and a man started at ordinary walking gait to sprinkle it over the entire old paving, the idea being to lay this coat as thin as possible, merely a paint coat. In about 24 hours it should be dry and ready for the binder coat. As a test to see if the paint coat is dry enough to proceed with the work, press the thumb against the surface of the old paving, and upon removal the thumb should show no perceptible stain.

The Binder Coat

The idea of a binder coat is to fill up all the depressions in the old paving, and to build up a new even cross section upon which to lay the final wearing surface. It has been found sufficient to provide for a 1-in. binder coat in the contract, using more or less thickness as circumstances require. This binder coat is what is known as a close binder, and is made up of stone ranging from ¾ in. down to ¼ in., three sand gradings, stone dust and asphalt. The proportions used in making this binder will vary with the material at hand, very much as Portland cement concrete materials are varied to produce a concrete suitable for the work at hand. The stone dust mentioned may

be replaced by any inert material of 150 to 200-mesh, meeting the specifications for fineness, and is often a percentage of Portland cement. This binder coat must be so mixed as to remain firm after laying, show no signs of disintegration under the action of wagons or trucks bringing in the wearing surface over it, and yet must be porous enough to permit of the perfect welding of the top surface material to it; especially it must show no evidence of excess asphalt, or greasy spots.

The Materials to be Used

In general, and as a guide from which to deviate towards the perfect mix which alone can be determined after a sieve analysis of the available materials for the aggregate has been made we should suggest the following from which the actual percentage of the various materials used may be computed.

In a batch mix of 5,100 lbs, we should start with a mix about as follows: Asphalt cement, 225 lbs.; filler material, 450 lbs.; sand, all grades, 1,425 lbs., and stone between ¾ in. and ¼ in., 3,000 lbs. This mixture is produced in a regular plant built for the purpose of making asphaltic concrete, and should be delivered on the work at about 275 deg. F. This binder must be raked and rolled with a heavy tandem roller and when finished, should present the street of the grade and cross-section desired, less the thickness of the wearing surface.

After the binder coat is laid for about a day's run of the plant, the gang is turned back and the wearing surface is spread. This wearing surface of asphaltic concrete, should be not less than 2 ins. thick in any place, either when laid in strips or when covering the entire street from curb to curb, and the difference between this thickness and the actual material necessary to bring the new pavement to the grade desired from the surface of the old pavement, represents the thickness of the binder coat.

It is not thought necessary to enter into the discussion of the making of asphaltic concrete in this paper, the intent being to show what preparation of the old surface is necessary before laying the final wearing surface. The mistake has been made of using no binder coat, the reconstruction proceeding with the use of asphaltic concrete only of variable depths according to the condition of the old pavements. This practice should not be encouraged for it has been found that to be the most successful, the actual wearing surface should not exceed 2-ins. in thickness, and where additional depth is necessary, it should be made with a binder mix. By such a procedure, better rolling of the hot materials on the lower strata is secured, and the binder coat containing less asphalt than the new wearing surface, will afford less liability of creeping of the new paving. There is also to be considered the less cost of the binder material as compared to the cost of surface material.

After such a procedure as above indicated, if the old pavement is firm there is no particular reason why any and all traffic should not return to the use of the street, though sometimes after such treatment the street is restricted to the use of pleasure vehicles only. Such an action should properly belong to the pleasure of the local government.

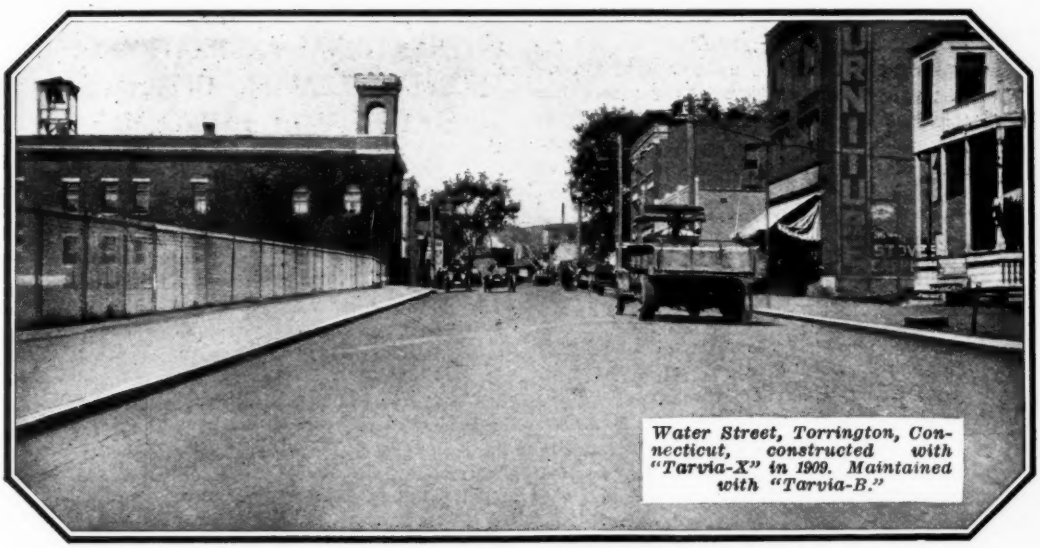
As to the cost of the procedure here described as compared with removing the old surface, laying a concrete base, and new 2-inch wearing surface, we should say roughly, it can be done for a third to one-half of the cost of new paving. This is the item which will appeal to the taxpayers perhaps more than any other, and it is one of the items which renders this type of reconstruction worthy of consideration by engineers, while another item is the rapidity with which it may be accomplished.

TYPES OF HIGHWAY PAVEMENTS IN TENNESSEE

By C. H. Olmstead, District Engineer, Tennessee Department of Highways, 327 Seventh Ave., North, Nashville, Tenn.

Tennessee is divided geographically into three divisions, east, middle and west. This division being a natural one, has become accepted practice in political and legislative affairs. These divisions, aside from their geographical designation, vary greatly in their topography and geology. East Tennessee has its mountains, Middle Tennesseee, its hills, valleys, river and creek bottoms, and West Tennessee has its low flat lands. The Tennessee river is the dividing line.

From the standpoint of highway materials, rock abounds in East and Middle Tennessee, while West Tennessee has none. East Tennessee has some good sand, mainly around Chattanooga; Middle Tennessee has only the Cumberland River sand, as the Tennessee River sands and nearly all creek sands are not suitable for extensive highway work. West Tennessee has good sand. Excellent chert abounds in many counties in Middle Ten-



Water Street, Torrington, Connecticut, constructed with "Tarvia-X" in 1909. Maintained with "Tarvia-B."

A Tarvia pavement— ten years old and still new—

THE Tarvia road above is Water Street, Torrington, Connecticut.

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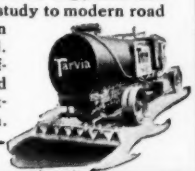

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nessee. This material makes a road superior to waterbound macadam, and more easily maintained. While Tennessee has many fine clay deposits, there is little paving brick manufactured, owing to the lack of base material and cost of hauling.

On account of the abundance of good rock, mainly limestone, we have a preponderance of pavements of the macadam type under construction at this time. Tennessee now has under construction:

100.68 miles of waterbound macadam;
160.43 miles of bituminous macadam;
38.85 miles of chert roads.

Owing to the distribution of sand and stone, concrete pavement is being constructed only in Hamilton and McMinn counties, where both are available; 4.37 miles has been constructed, and 24.65 miles are under construction.

In West Tennessee, bituminous macadam and bituminous concrete on a macadam base are being constructed.

Owing to the availability of rock asphalt in Kentucky, this material has come into use in East and Middle Tennessee, where 46.57 miles are under construction, rock asphalt being laid on a macadam base. Bituminous macadam and rock asphalt have been laid on a two-course macadam base, 6 ins. thick, but a modified Telford base 8 ins. thick is now being used. The modified Telford base is made of field or quarry rock, laid in shingle fashion, with the longest dimensions at right angles to the center line of the road and napped in place.

The bulk of the highway construction is being done on a contract basis, but force account work on a day labor basis is being done on three macadam projects, aggregating 16.77 miles. One concrete highway project, 10.14 miles, is being constructed by county forces, under supervision of engineers of the State Highway Department, at fixed unit prices, making it essentially a contract job, with the county as the contractor.

The Federal-aid construction is carried on upon a basis of the federal government paying one-half, the state and county paying one-half.

The Federal-aid program for 1921 calls for the construction of 271.75 miles of highways, surfaced with the various types and having an estimated cost of $8,575,900 and bridges at an estimated cost of $370,000.

INTERNATIONAL ASSOCIATION OF STREET CLEANING OFFICIALS SUCCESSFULLY LAUNCHED

On the invitation of W. J. Galligan, Assistant Superintendent of Streets, in the city of Chicago, 44 street cleaning officials from 28 United States and Canadian cities met in Chicago on October 7 and 8, 1920, and organized the International Association of Street Cleaning Officials. The objects of the association, as stated in the constitution adopted, are: "The acquisition of knowledge relating to the cleaning of streets and the dissemination of this knowledge among the members of this association, with the view of improving the service and reducing the cost, and the establishment and maintenance of the spirit of fraternity among its members."

Membership

Members are of four classes—active, associate, honorary and life. Active membership is limited to superintendents of street cleaning departments in municipalities and towns of the United States and Canada, and "other persons having charge of or connected with municipal street cleaning departments." Membership of active members is continuous, when once elected, whether they continue in employ of their various municipalities or not. Associate members are "manufacturers of and dealers in appliances relating to the interests kindred to the association."

Officers

Officers are President, Vice-President, Secretary, Treasurer, and a board of governors of five members. The members of the board of governors are chosen one from each of six districts, the United States being divided into five and the Dominion of Canada forming the sixth, except that none is chosen from that district from which the President is elected. Officers elected for the coming year are as follows:

President, W. J. Galligan, Assistant Superintendent of Streets, Chicago, Ill.; Vice-President, Theodore Eichhorn, Superintendent of Streets, Erie, Pa.; Secretary, A. M. Anderson, 1340 Old Colony Bldg., Chicago, Ill.; Treasurer, Robert W. Waddell, City Engineer, Kansas City, Mo.; Board of Governors, Abraham Swan, Jr., Engineer of Streets, Trenton, N. J.; J. W. Motte, Director of Public Works, Savannah, Ga.; F. W. Doane, City Engineer, Halifax, Nova Scotia; W. B. Lowry, Manager of Parks and Improvements, Denver, Colo., and Peter J. Owen, Superintendent of Streets, San Francisco, Calif.

WATER WORKS SECTION

PROGRESSIVE LOSS OF RESIDUAL PRESSURES IN A WATER WORKS SYSTEM

By Waldo S. Coulter, Consulting Engineer, 114 Liberty Street, New York City.

It is not uncommon to encounter communities where a notable loss of residual pressures throughout the water works system has been progressively brought about by an unusually large and rapid increase of domestic and industrial consumption.

Notable increases in industrial consumption, in particular, operate to hasten the process. The loss first becomes noticeable in connection with fire protection service. Whereas, at first the hydrant pressure alone may have been sufficient for fighting fires, lessened residual pressures and discharge will finally bring about the use of pumpers. At a later stage, unless corrected, losses will proceed to a point where they will be forcibly brought to the attention of the consumers by the failure of water to flow from taps on the upper floors of buildings in the higher portion of the city.

This may first occur during a time of unusually heavy consumption, such as a period of extremely cold weather, when the general opening of taps to prevent the freezing of pipes, may bring about a simultaneous failure of the supply on upper floors over a large portion of the city, and cause a vigorous public demand for improvement.

Experience at Bayonne, N. J.

Something of the sort occurred in the city of Bayonne, N. J., during the unusually cold weather in January, 1918. The writer conducted an investigation for the city at that time, and the general situation disclosed may be of interest. It may be stated that these conditions have since been removed by the installation of additional trunk lines to the city and the construction of a booster station at the point where they connect with the distribution system.

Bayonne is located on a long, narrow peninsula located between Newark Bay and Upper New York Bay, and has a population of about 65,000. The trunk lines enter the distribution system near the upper end of the peninsula and the main arteries of the latter extend longitudinally toward its point, with frequent ample cross-connections.

Since 1910, Bayonne has developed industrially with great rapidity, and is now the home of some of the country's largest industries. Most of these are located toward the point of the peninsula.

By 1918 the average daily consumption had reached 10¼ million gallons, having doubled during the preceding seven years. At the time the trunk lines were first connected to the system, 1894, the average daily consumption was less than 2½ million gallons, and the distribution system was of comparatively limited extent.

The pressure at the entrance to the distribution system was then 45 lbs., which was, as such matters were looked upon at that time, considered sufficient.

While the distribution system was, and is, in general, well designed, and arranged to avoid unreasonable losses of pressure by friction, there was a constantly increasing and legitimate diminution of residual pressures throughout the system. These progressive pressure losses arose from the increased flow through the pipes consequent on the rapid growth of population and manufacturing industries, causing increased friction losses and lower residual pressures. The lengthening of the piping by extensions contributed to further increase the friction losses. As the friction loss varies approximately as the square of the velocity of flow, if the velocity in a given pipe be doubled, the friction loss is quadrupled. When, therefore, a marked deficiency of residual pressure asserts itself in a system, associated with a rapid and continuous increase in the rate of flow, intolerable conditions are speedily precipitated.

Great Friction Losses

The peninsula upon which Bayonne is situated is comparatively level, without marked variations that might offset friction losses in the pipes. The residual pressures throughout the city were therefore chiefly dependent on the pressure communicated to the distribution system at the point where it was joined by the

trunk lines. Any distribution system is, of course, entitled to certain legitimate losses of pressure. After such losses have been deducted from the initial pressure there should remain residual pressures and flows sufficient, not only for domestic and manufacturing purposes, but to afford ample fire protection throughout the system. The sum of the legitimate net losses (taking the topography into consideration) and the required maximum residual pressure for domestic and fire flows, equals the pressure that should be provided at the inlet to the distribution system. Computations showed that this initial pressure should have been, in 1918, about 70 lbs., instead of 45 lbs. The difficulties were increased owing to the fact that friction losses in the trunk lines, coincident with increased flows, rendered it impossible to maintain even 45 lbs. at the inlet to the distributing system.

Whereas, in earlier years, the hydrant pressure alone was frequently used to fight fires, for some time before 1918 the residual pressures had been reduced so low that a stream could be projected, with hydrant pressure, only 10 ft. or thereabouts from the nozzle.

The effects of this continuous diminution of residual pressures first became very noticeable to citizens in 1915, which would appear to indicate that prior to that time the pressure had not been reduced to a point where domestic consumers were seriously inconvenienced, although test data of the insurance bodies show that markedly deficient fire pressures were of longer standing.

War Industries Increase Loads on Large Mains

In addition to the rapidly increasing consumption of Bayonne, other important causes originated during 1917 to increase the load on the trunk lines. Where the latter passed through the Newark meadows on the way to the city, great war industries had sprung up, for which no other source of water existed. The draft upon the trunk lines by these industries increased from 100,000 gals. per day in July, 1917, to 1,800,000 gals. per day in January, 1918, with every prospect of a continued rapid increase during 1918. Adding the average daily consumption of the city for the latter portion of 1917 to the average daily consumption of these meadow consumers for January, 1918, with a deduction of 300,000 from the latter to allow for abnormal cold weather consumption during that month, gave a grand total of 11¾ million gals. per day, with the prospect of an increase in rate of from 1,000,000 to 2,000,000 gals. per day during the year 1918.

Additional Trunk Lines and Booster Station Installed

This pyramiding of consumption culminated in a complete collapse brought about by the abnormal consumption associated with the period of extremely cold weather in January, 1918. This circumstance but somewhat hastened the day of reckoning, which was not far distant in any event.

The objectionable conditions have since been removed by the construction of additional trunk lines and the installation of a booster station.

PUBLICITY IN UTILITY SALES

By W. Malcolm Lowry, of Henrici-Lowry Engineering Co., Consulting Engineers, 222 Commerce Trust Bldg., Kansas City, Mo.

Correct and constructive publicity has done much to relieve the unfortunate criticism relative to many of our large commercial institutions. The apparent frankness of these corporations through their publicity departments has convinced the general public that the cost of their commodities has been fairly, even if not correctly, determined.

The thing that will engender better feeling and help the general attitude of the citizens toward the rates charged by the local utilities, either municipally or privately owned, is publicity.

The recent convention of Building Managers held in a northern city developed the sentiment that even that profession was not properly understood and should undertake to explain to its clients the make-up of their rental rates. This publicity will show how each item of expense is justified and a complete analysis of the rates charged in each building.

Information Mailed With Monthly Bills

Public utilities should be equally frank. Each month when the statement is mailed a little insert could be enclosed setting forth just one item of percentage cost. Each month should show the new items as well as the recapitulation of previous ones. The entire analysis should be prepared in advance so that the percentage would be complete with the final exhibit; but by continuing the story over several months, the interest of the patrons would be retained.

These exhibits could show that of each 1,000 gals. of water pumped a certain stated percentage was chargeable to coal, another to plant salaries, another to outside employes, another to executives, an-

other to new hydrants or machinery, another to plant distribution, plant maintenance and so on through many classifications. This would be a very inexpensive way to advertise the plant operations and would have a tendency to solidify the confidence of the public in the local plant.

To Prospective Customers.

To prospective customers the entire analysis could be forwarded at the beginning of the campaign for new accounts, and be followed with educational propaganda. The basis of meter unit could be explained showing how charges are computed. No manager should presume that his customers understand the technical points. The schedule of sliding charges for service would not complicate the analysis because the percentage could be kept proportionate, and the system generally explained.

Small sectional pictures of the inside of the plant would be interesting as well as constructive. In these days when so many of the schools provide science courses for women, it is pleasing to note their added interest in matters of daily life and its necessities. The women customers would be glad to learn more of the elementary details pertaining to the manufacture of electricity which is used to heat their percolator or iron as well as the means of purifying the water served on the table.

Simple instructions could be set forth in connection with thawing out water pipes or the dangers of amateur wiring of fixtures.

Value of Sustained Effort in Publicity

It is not of so much importance just what is covered in the matter of publicity as it is to keep continually in close touch with the consumer and prospective customer and show that there is an interest in their account other than the monthly collection of the rate.

Some of the states require that the fire underwriters furnish each customer a complete analysis showing the manner in which each separate rate is compiled. This has done much to relieve the antagonistic attitude of the insuring public. It also furnishes a basis for improvements which mean a saving to the customers. This would have the same tendency with all other lines of industry.

In some cities this could not be handled without some explanation in reference to certain commodities consumed. At some locations the increased freight charges have added heavily to all purchases, especially fuel. This increase would not apply to all plants alike, but could easily be justified by complete detailing the present rates and would at least be interesting to the consumer. Comparisons of other plants could be occasionally made.

The newspapers could also be pressed into service. In one city the tax assessor is even advertising when and where the returns can be made. If the assessor has found it advisable to advertise although his customers are in no wise subject to competitive service, why should a utility imagine its customers are any less human?

The entire matter should be carried out without any partisan spirit and should be based on the theory that all employees are either on civil service or are the best talent available for their particular duty.

Criticism is too frequently destructive without any constructive suggestions.

Encouraging Public Confidence

Too much thought is given to making customers purchase the manufactured product without encouraging his confidence in the article.

Many of the plants now use some method of advertising at irregular intervals, but if a constructive and consecutive program were outlined upon an inexpensive basis, it would result in stimulating a comparison of plants upon a rated basis and would be an economical saving to the ultimate consumer.

Courtesy in service is naturally expected and should be insisted upon by all executives.

Proper care should be used in the manufacture and delivery of all commodities, be it water or electricity.

Reasonable performance of the machinery is to be required.

These are natural details to expect. What are the details that you would appreciate were you on the outside of the plant and entirely unfamiliar with ordinary routine? There are many things you would like to find out. So it is with many of your customers, and a little data carefully and accurately prepared and presented in a concise manner will increase the output of your plant.

This is the day when customers desire to have a little interest in a plant or an institution more than they pay for. They believe in the safety of the national bank, but they also enjoy having the president of their selected institution come out and shake hands and show a little evidence of being an interested friend and not altogether a cold but successful financier.

A utility can build up the same support through friendly publicity.

The possibilities for this campaign are legion, and judging from efforts already put forth local managers are endeavoring to get on a more friendly basis with their customers.

This is the age of co-operation.

THE VALUE OF MUNICIPAL UTILITIES TO A COMMUNITY

By John F. Druar, of Druar and Milinowski, Consulting Engineers, 512 Globe Bldg., St. Paul, Minn.

(Editor's Note: Mr. Druar has contributed to this journal before and we are pleased to announce that articles from him on water supply, sewerage and paving subjects will appear in future issues.)

The crying need of cities of the third and fourth class and villages and towns throughout the country is a careful, prudent and economical development of their public utilities.

By public utilities, I mean the water supply and distribution, the sanitary and storm sewers, disposal of municipal and trade wastes, road and street improvements, sidewalks, curbs and gutters, pavements, electric lights, central steam heating systems, telephones, transportation, parks, lakes, and, in fact, anything that could be included in city planning.

Heretofore not enough attention has been given to the development of a municipality. Most small cities, "like Topsy," have "just growed."

Factors Arresting Development of Small Towns

Jim Smith thinks one thing, Bill Jones another. Perhaps they never get together, but Smith goes out and buys a patent disposal tank, puts it in his yard and equips his house with a modern inside toilet with a well and pneumatic water supply costing from $500 to $1,000. Smith, on the other hand, wants the village to take care of both water and sewer. He mentions the fact to the local council and Brown, a retired farmer, at once takes exception to any forward movement. He feels that what he had on the farm is good enough for him in town. There are a number of Browns and a number of Smiths. The Joneses are in the minority and proceed to talk for a municipal system. They win over a few Smiths and Browns; enough to get the village council started and the council proceeds to guess as to how much such a system will cost.

Guessing at the Cost

Right here is the place for them to engage a first-class engineer, one who has had experience in municipal work, to make a report on the project, which will crystallize public thought. Sometimes this is done. At other times, price, not reputation based on long successful practice, is the only consideration that is given to the selection of the engineer and the difference of 1% in the cost of engineering may mean the securing of inferior engineering services, which may result in a final cost of the improvement several thousand dollars in excess of what it ought to be; and the design may be poor. Again they may proceed as far as the bond issue without the advice of an engineer, only to find that they have not secured enough money for the project. Or, through want of proper explanation to the people, the bond issue may fail to carry.

Let us assume that an average city or village of, say 1,000 inhabitants, is desirous of securing municipal improvements. The town now has a number of houses with plumbing, pressure tanks and wells all on the premises, thus affording sewers and water to a few. Some one starts agitation for a water system and there are several informal discussions that lead nowhere because reliable information is lacking on which to base them. The banker or other business man suggests having an engineer come to address a public meeting and correspondence is taken up. Some engineers will visit the village and do a little development work just to start the proposition on the right track. Others from the outset will demand the guarantee of a fee. This demand may mean that the council or committee will abandon the movement for the time being and forget about the advantages.

Missionary Work by the Engineer

A good municipal engineer recognizes the need of a little missionary work and he will therefore visit the village even at his own expense and do what he can toward helping the community, of course, expecting that if anything is done, he will secure the work.

The village, on the other hand, should be careful not to engage an engineer who has not had a great deal of experience in municipal engineering. Many a poor piece of work is done because of inexperience.

An Impossible Fee

Some times the cheapness of an in-

ferior engineer appeals to the council, and they will actually engage a man who proposes to draw plans and supervise the work and keep a resident engineer in attendance at all times for 2½ or 3% of the cost of the work. It cannot be done. The percentage asked points out the fact that the engineer does not know the cost of the work. Again some young engineer comes on, just out of college, with no practical experience, and becomes a self-styled consulting engineer over night. He puts out a shingle, engages in practice and perhaps secures work, possibly important work. He is at sea as to costs and many other matters. If the work goes in well it is because of luck only and generally the cost will be excessive.

A Fair Fee

A good standard fee for work of $40,000 or more, requiring survey, tests, plans and details, careful special specifications, bidding forms and attendance at the letting, would be 3% of the cost of the work and such fee should cover report, estimates and attendance at a mass meeting to explain how the money will be spent, so that the citizens may know the general plan, the benefits derived and the approximate cost to the individual property owner. If this method is closely followed the results are good, the bond issue carries, plans are drawn and the work let. Sometimes there may be a pool and it is the duty of the engineer, through his experience, to sit in judgment and to guide the council by his past experience as to whether the bids should be rejected or the work let to the lowest responsible bidder. This is the point where experience counts.

The Measure of Experience

An engineer is born and not made. You can pile technical training on a man for years, but unless he has a vivid, well-controlled imagination, a knack of knowing how to do things and unless this is backed by five to ten years of practical diversified construction and field experience in responsible charge of men and construction, he is not the engineer for the work. He has, of course, to make a start some time, but is not particularly reliable for his first, say 25 jobs. By this I mean he finds mistakes in his own plans, sees where they could be bettered after the work has been performed and where the costs could have been cut by other methods. In other words, he is going through the experimental stage. After considerable experience material men and patent appliances which have not been thoroughly tested no longer interest him and he takes no chances, trusting that the work will be lucky. He finds himself and becomes as reliable as the Western Union clock, provided he does not step out of his province and attempt too big a program. He has found that honesty is the best policy, that good work builds a good reputation, and that one job done well gives him added work.

When the Contract is Let

Now, when the work is let, the engineer makes an additional charge for general supervision of not less than 2%, which fee will allow him to be generous with his time and attend special meetings for explanation and discussion, and allow him to visit the work to see that the resident engineer is performing his duty.

The engineer, for the sum of $250 or $300 a month will put a special resident engineer in the field to have actual supervision over the contractor and see that the proper materials and quantities are used.

I rather favor having the contractor figure on reimbursing the village for this service and suggest that the sum of $250 or $300 a month (depending on the grade of the engineer and his duties) be deducted from his contract price of the work for each month spent in construction. This then causes the contractor to supply his materials and equipment and use his best efforts to complete the contract.

The Contractor

Unfortunately some contractors are not as well equipped for the work as others, and while I have known contractors to finish a $60,000 water job in two months, I have known others to dally along for a year on a $40,000 job, losing money for the city as well as for all others concerned. Therefore, in putting a penalty of this sort on the contractor, I know he will give personal attention to the work in hand and better service will be obtained all the way through. The contractor bidding on the work should be familiar with it and have successfully completed work of similar nature.

Much trouble is saved by clear plans and specifications, and if these are adequate no argument ensues, and this makes for a general good feeling and rapidity of construction.

The cost of municipal improvements is not large. One can be up-to-date in his municipality and have all the comforts

of life, for less than it costs to exist without such improvements. This has probably never occurred to him, but it is a fact.

The citizen wants an automobile and is up-to-date in that way. He thinks nothing of spending for pleasure, but a slight tax for water, sewer, or pavement —no! He is opposed to it as much as if it were on a par with the Boston Tea Party. He feels like inaugurating such a party to protest. When will the American people wake up? Last year all over the United States $700,000,000 was spent for education, an absolute necessity, and $22,000,000,000 was spent for pleasure by the American people!

Cost of Residential Water and Sewerage

The citizen should think in terms of improvements for his community. I will take water and sewer first. The private individual builds a new house. I shall leave out the plumbing in the house, for each can have his own taste gratified in that respect. A bath room with all appliances can be equipped for $75 up and would include a kitchen sink and roughing in the plumbing. What is the first cost to an individual of putting in his own well, pump and storage tank? I shall assume that electricity is available for motive power. The least cost for a well, pump and pressure system installed would be approximately $300. Then there is the cost of a cess-pool or septic tank in the yard. This and the connections would cost at least $200, making the minimum for sewer and water for inside toilet and conveniences $500. This is to say nothing of interest on the investment, the cost of repairs and replacements, etc.

Now, with an out-house in the back yard, there is the first cost to build and paint of not less than $75. It costs about $10 each time it is cleaned, which may be once or more often a year. All are familiar with the conditions of visiting this place daily in all kinds of weather and in sickness and in health. Can anyone see how people have put up with it for so long a time?

Suppose the citizen has a well; perhaps a shallow one. If so, the pump and well cost from $75 to $100, and he or his wife (usually friend wife) pumps and carries the water every day in all kinds of weather, running the chance of catching cold, or slipping and injuring herself in the winter. He runs a good chance of having his well contaminated by his own or his neighbor's out-house and neither one of these utilities, that cost him at least $150, for both, and at least $10 a year to keep in a clean condition and in repair, is worth the expense and trouble in comparison with the actual cost of an up-to-date sewer and water system laid in the streets for all time. The useful life of a cast-iron water main is at least 80 years, and that of the vitrified sewer equally as long.

Suppose a town of 1,000 wants sewer and water, and that the town is not too widely scattered and the digging conditions are average. It has been my experience that water and sewers can be fittingly installed, first, to give a plentiful supply of pure, clean, wholesome water, suitably stored in such volume as to be wholly adequate for fire and domestic service. Then the street mains would be installed in each street of such size as to be adequate for the future increase of population. The pumping equipment and pump house would be neat and serviceable. The citizen would gain by such an installation wonderful advantages, some of which are as follows:

Advantages from Public Systems

Betterment of public health, the promotion of cleanliness, the larger use of water for cleaning, sprinkling and garden work. The main advantage from the standpoint of economy is the big saving afforded the entire community by the reduction of insurance rates. The reduction varies from 15 to 50% on the annual premium. With such a system and a volunteer fire force one can have a stream of water on a burning house in from 2 to 5 minutes, thus saving valuable and unreplaceable property to the owner, village, state and nation. One must realize that he or the nation are absolutely powerless to recover burned or destroyed property.

To do away with the out-house, the menace to public health, through becoming the breeding place of flies, the distribution point of unhealthful odors, the backing through the soil to your well of filth, it is only necessary to install a system of sewers to obtain permanent relief, at no further expense than the first cost, if a village happens to be on a stream of water of sufficient size to allow the free discharge of the sewage. If, however, there is only a small stream a disposal tank would have to be installed and then there would be a small yearly cost to the village for pumping the sludge two or three times a year.

To Dwellers in Small Towns

Now prepare to be severely shocked:

Whether you have spent several hundred dollars putting in your own system, or whether you have one of the out-house variety, you have spent more on these conveniences than was necessary and you have no results. Bear in mind that in co-operation or union there is strength, and when a community clubs together for the purpose of water and sewer it can usually be accomplished for the small cost of $150 per 50 ft. of frontage and this is based on the actual present cost on the date of Feb. 1, 1921.

Now, who is there that will resist this small expenditure and fight against improvements? If you are not fixed to pay for this service in cash, you may, at your option, have from 5 to 10 years to pay for it, as provided by law in most states.

Think what it means to your community at large. If you decide on improvements a bond issue naturally follows, money comes to your town and you are bringing something to your community. The only money that leaves the town is what it costs for material, freight, contractor's profit, and your community absorbs small repairs, local supplies, board and room money spent by the people employed on the work, and, I may say, that mostly local labor is used.

There is no economy in waiting and putting off either of these improvements. Disease and death follow in the wake of the outhouse and old well in the yard. Is your town to continue to be a place to avoid as lacking the commonly recognized necessary conveniences, or is it to be a cleanly, sanitary upgrowing community which will be attractive to the prospective citizen?

WELDING CRACKED PUMP CYLINDER BY THERMIT PROCESS

The accompanying illustrations show how an unusual welding repair was recently made on a large cast steel water cylinder of a steam pump operated by the city of East Liverpool (Ohio) water works.

The casting had developed a crack of about 20 ins. in length. An attempt was made to repair it by oxy-acetylene welding, but a crack again developed as a result of contraction strains and the cylinder was then welded by the thermit process.

In welding the casting, the broken sections were lined up, leaving a small gap between them, to provide space for the thermit steel later to enter. Yellow pattern wax was then inserted in the space and a mold formed around the wax. A preheating torch was then directed into the mold for the purpose of drying it out, burning out the pattern wax and pre-

FIG. 1. GAP CUT OUT AT FRACTURE OF DEFECTIVE CYLINDER PREPARATORY TO WELDING.

heating the sections to be welded. Finally, when the sections were heated sufficiently for welding, a charge of thermit (which is a mixture of iron oxide and aluminum) was ignited in a crucible suspended over the mold. The chemical re-

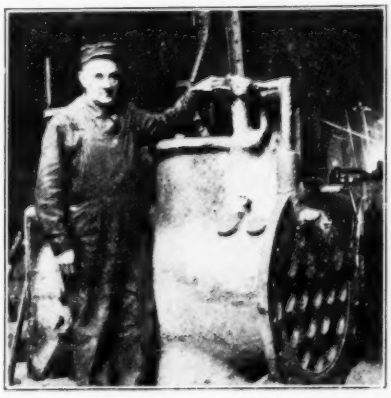

FIG. 2. WELDED CYLINDER BEFORE REMOVING CAST WELDED METAL.

action was started at the extremely high temperature of about 5,000 deg. F., during which the aluminum combined with the oxygen of the iron oxide to form aluminum oxide or slag in a highly superheat-

ed molten state, while the iron was set free and produced as liquid steel. The reaction required only about 35 secs., at the end of which time the liquid steel which had been precipitated to the bottom of the crucible, was tapped into the mold, and amalgamated thoroughly with the broken surfaces of the two sections.

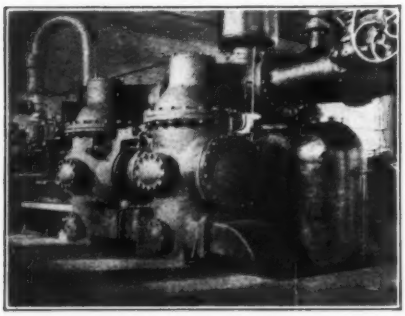

FIG. 3. STEAM PUMP IN WHICH WELDED CYLINDER OPERATED.

The metal of the weld was allowed to cool slowly, after which the molding material was removed, the excess metal cut off, and the welded cylinder returned to service.

Figure 3 shows a view of the pump after the welded casting had been replaced in operation and was giving perfect satisfaction while being operated constantly under a pressure of about 130 lbs. per sq. in., pumping filtered water up to a reservoir.

MODERN PRACTICE IN SUPPLYING WATER TO ISOLATED RESIDENCES

By G. C. Blalock, Asst. Prof. of Electrical Engineering, Purdue University, Lafayette, Ind.

The greatest objection to residence in isolated districts or dwellings is removed when modern conveniences in the way of light, water supply and sewage disposal are made available. Dependable electric generating and storage equipment is now available in small units for light and power service; also electric companies are beginning to see the possibilities in rural distribution. This makes possible the automatic pressure water system; numerous types and capacities of which are now to be had at moderate cost. An abundance of water makes practicable modern plumbing and sewage disposal apparatus, which also is now within reach of men of moderate incomes. So, with quick and efficient methods of travel and communication at hand, remote residence has lost its terrors and isolation becomes a thing of the past.

Great Variety of Residence Water Systems

The number and variety of residence water systems now being manufactured is truly amazing, when one considers how short the time has been since the well sweep and the rope pulley were the accepted means for elevating water on the farm. For less than the price of our most popular make of automobile the average farmer can have a reliable and adequate water supply—the equipment for which is simple, easily cared for and capable of giving years of service at very reasonable operating expense.

The demand for information concerning these systems has led recently to an investigation and study of available types and their characteristics by members of the Engineering Experiment Station Staff of Purdue University. The Farm Mechanics Department has co-operated with the Electrical Engineering School in making tests of complete electrically-driven equipments as well as their driving motors, and various dealers and manufacturers have generously loaned samples of their product for this purpose; deriving an indirect benefit from the publicity given this latest addition to modern farm equipment.

The elevated tank storage formerly used with hand, windmill or power pumps has given way to the hydro-pneumatic tank and this in turn is now being reduced in many cases to small capacities, or eliminated entirely so far as water storage is concerned. Residence systems of this kind are commonly sold as complete units and, particularly in the smaller capacity systems, are assembled with a view to cutting the required floor space to a minimum. They may be obtained with gasoline engine drive or electric motor drive, but the latter arrangement is the more popular where electricity is available, because of the automatic feature. The engine-driven system can easily be made self-stopping, but cannot well be made self-starting.

Pump Capacities

The reciprocating, suction-lift type of pump is most frequently encountered in this section of the country. The smallest practicable capacity appears to be 100 gals. per hour, requiring a ¼ h.p. motor and commonly assembled with a tank of not exceeding 50 gals. capacity. The

Water Works Companies

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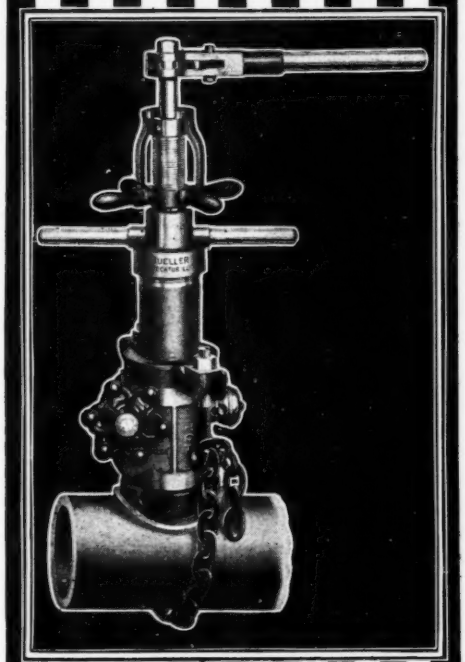

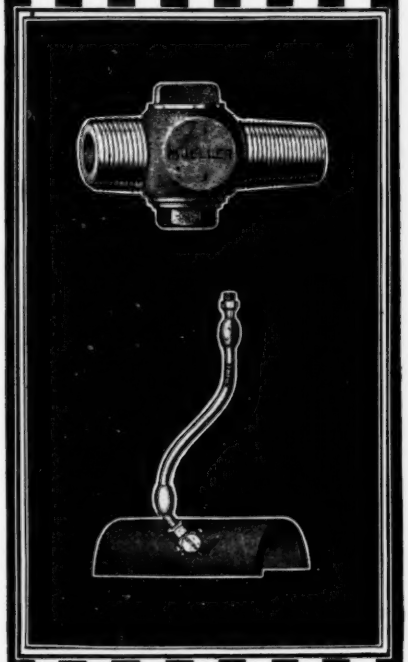

pressure operated switch then automatically maintains the tank pressure between certain limits; starting the motor when the lower limit has been reached, and stopping it when the pressure has attained the upper limit. This capacity of pump is sufficient for soft water supply in the average household and finds frequent application for this purpose in cities, where it appears to be superseding the hydraulic pump operated from city water pressure. It is, however, too low in capacity to be used for general water supply in any but the smallest families, and where no stock watering or lawn sprinkling is involved.

For more general purposes similar outfits are available in capacities ranging from 180, 250 and 300 gals. per hour, with motors of ¼ to ½ h.p. to those for large farms, estates and institutions having capacities of 1,000 to 1,500 gals. per hour and requiring motors of 1½ to 2 h.p. The needs of the average farmer will probably be well provided for by systems having capacities of 360 to 720 gals. per hour, requiring motor capacity of ½ to 1 h.p.; 360 gals. per hour, or 6 gals. per min. is sufficient to supply a single line of ordinary ¾-in. garden hose.

Tank Capacities

The tank supplied with each outfit will depend upon individual requirements. The larger tanks offer some degree of protection against interruption due to break-down of pumping equipment, but their greatest advantage lies in the reserve afforded by them for fire protection. It should be noted, however, that a tank used in this way has a water capacity only about 2/3 of its total capacity and that not all of the stored water is available at a useful working pressure. It is evident, therefore, that a tank large enough to afford any considerable measure of protection will add very materially to the cost of the outfit. The present trend seems to be toward reduction of the tank to a capacity only large enough to provide the necessary elasticity for the system and guard against unnecessary operation of the pump from reduction in pressure by leaky fixtures. This throws more responsibility upon the pumping equipment but results in a more compact and less expensive installation.

The same general features pertain to the deep-well as to the shallow well outfits except that the deep-well pump cylinder must be placed in the well and requires therefore that the pumping head be placed directly over the well; eliminating the flexibility as to arrangement of apparatus which is incident to the suction lift systems. The power required in the driving motor for a given capacity and tank pressure becomes correspondingly greater, of course, as the depth to water increases.

Pneumatic Systems

The second type of water system in general use is the purely pneumatic system, in which the tank is used for storage of compressed air; the air doing the actual pumping. The motor drives an air compressor and automatically maintains the pressure in the tank between fixed limits. An air line is carried to a pump, operating on the pulsometer principle, which is located beneath the permanent water level in the well. The pump operates and elevates water only when the pressure in the water line is reduced, as by the opening of a faucet. As regards capacity of the system about the same condition holds here as in the hydropneumatic system. Unless a tank of considerable size is provided the capacity of the system to meet a sustained demand depends upon capacity of compressor and driving motor. For satisfactory operation on the farm, therefore, the compressor should be able to supply air at a rate corresponding to at least a 6 gal. per min. output of water from a ¾-in. hose line.

A Modified Rotary Pump

A third type of shallow well pump, adapted to residence systems, has recently been placed on the market and is reputed to be meeting with a fair degree of success. Its operation is based upon a modified rotary-pump principle, but the rotor consists of one instead of two moving parts. Direct-conected to its driving motor and mounted alongside a very small pressure tank a system is formed which for simplicity and compactness could hardly be excelled. Its chief disadvantage lies in the fact that it is not self-priming and requires a well-fitted suction line and foot-valve for successful use with an automatic system.

The type of motor supplied with these outfits depends, of course, upon the nature of the available power.

Electric Motors

Motors are available for the ordinary commercial voltages and frequencies and for the 32-volt farm lighting units. For direct current operation the type usually supplied is the compound wound motor, because of the necessity for a high starting torque in displacement pump operation. No difficulty need be experienced with this motor provided it is kept free

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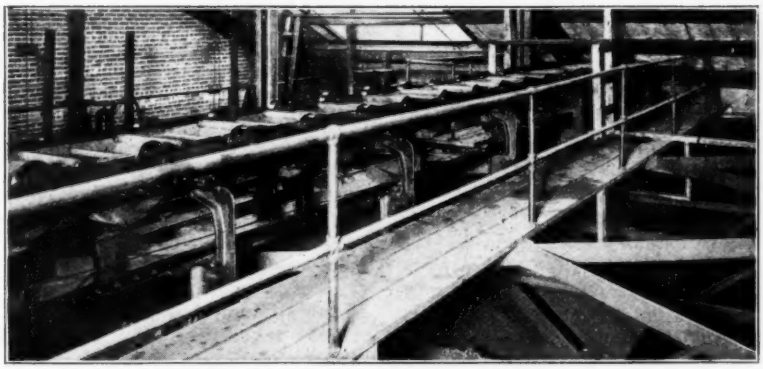

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from dirt and moisture. For alternating current operation the single phase lighting circuits are commonly used, and for this reason the simplest, most rugged types of a.c. motors are not available. The single phase induction motor must have an auxiliary starting device of some kind and this starting device is sometimes the source of much trouble, annoyance and expense, particularly in locations where the voltage may at times be considerably below normal.

The two types of a.c. motors commonly used are known as split-phase and repulsion-induction motors, because of the starting devices employed. The split-phase type can be depended upon to give good service where conditions are always normal or where the deviations are relatively slight, but the repulsion-start type is the more rugged and, as a power station man recently expressed it, has more "pep." The starting current required by the repulsion type motor is usually about three times normal current, while that required by the split-phase type is five to six times normal. This heavy starting current is supposed to last only for one or two seconds, but conditions may readily be such as to prolong this heavy demand to such an extent that fuses are blown or the windings injured. The former is annoying while the latter is both annoying and expensive. Despite its advantages, however, the repulsion start type of motor has not been generally adopted for this application because of its considerably greater first cost.

Test Data

Tests made on several displacement pump, compression tank outfits of 100 to 200 gal. per hour capacity showed overall efficencies of 15 to 25% under normal operating conditions, with 17.5% as a fair average. The efficiency increased with pressure but the pump is likely to operate at a reduced pressure for a large percentage of its total operating time. Motor efficiencies varied from 40 to 60%; with 50% as a fair average. Thus the pump efficiency in this type and size of outfit may be expected to average about 35%. These efficiencies result in a pumping duty of 2.1 to 1.25 kw.-hrs. per thousand gals. per 100 ft. head, with 1.8 as a fair average. Considering the capacities of these units this figure compares very favorably with the average for the smaller city pumping units over the state.

Watt-hour meters installed in several residences using compression tank systems for soft water supply to bath-room, kitchen and laundry revealed a maximum consumption of 0.75 kw.-hr. and an average of 0.45 kw.-hr. per person per month. So it is evident that at prevailing rates 1 ct. per day for electric energy is sufficient to provide an abundant supply of soft water for the average city family. For general water supply, however, where lawn sprinkling, stock watering, etc., are involved, the requirements are much greater and the cost correspondingly higher.

Judging by the above figures on energy consumption the soft water requirements for a family of five people would be met by a pumpage of 1,250 to 1,500 gals. per month, while for the general water supply on a farm supplied with modern plumbing and sewage disposal arrangements, involving the same number of people and 15 to 25 head of stock, besides sprinkling and car-washing facilities, a pumpage of 750 to 1,000 gals. per day would be required. But the rapidity with which farms are being equipped with these systems indicates that the up-to-date farmer considers that the advantages far outweigh the costs.

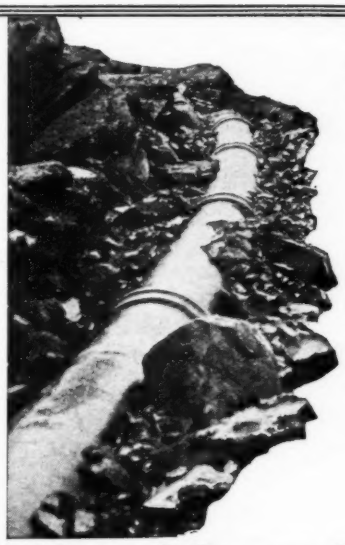
The foregoing paper, by Professor Blalock, was presented at the 1921 meeting of the Indiana Egnineering Society.

ODD GROWTH IN A WATER METER

To the Editor:

We are sending you a very curious mass of roots recently removed from a ¾-in. Trident water meter. This unique growth evidently resulted from a seed which

GROWTH REMOVED FROM ¾-IN. WATER METER AT LAREDO, TEXAS.



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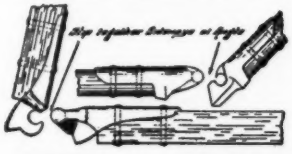

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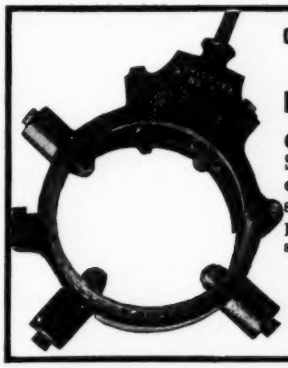

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found ingress through the small line and then developed afterwards in the water chamber of the meter. (A picture of the growth is shown herewith.)

This was found floating, in a spongy mass, just below the gear train, but it did not interfere, apparently, with the operation of the meter. A broken shaft in the gear train led to the discovery of this curiosity.

This is so unique an indication of what water meters are sometimes required to put up with that we thought perhaps the readers of Municipal and County Engineering would be interested in it.

Very truly yours,

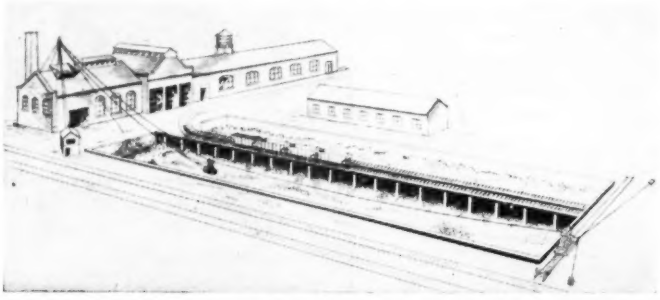
F. A. MATTHES, Manager
Laredo Water Co.

Laredo, Tex., Jan. 7, 1921.

NEW METHOD OF MOVING STORED COAL

A new method of reclaiming coal from storage that appears to be suitable for many central station and municipal electric light and water plants has been adopted by the Indianapolis Light and Heat Co., Indianapolis, Ind.

A Sauerman dragline cableway excavator, ordinarily thought of as a machine for gravel handling and earth-moving operations, is successfully employed at the Indianapolis power plant to handle 500 tons of coal per day from the concrete storage pit to a hopper built into the roof above the bunkers. One man controls the entire operation of loading the bucket, conveying and dumping. The total span of the cableway is 550 ft. The bucket holds about two tons of coal and averages 30 trips per hour. The installation is illustrated herewith.



SAUERMAN DRAGLINE CABLEWAY EXCAVATOR USED BY AN INDIANAPOLIS POWER PLANT IN HANDLING STORED COAL.

PHILADELPHIA EXHUMES $70,000 WORTH OF CAST IRON PIPE

(Editor's Note:—The following item appeared in the Philadelphia, Pa., Inquirer of Dec. 26, 1920. For verification we sent it to Mr. Carleton E. Davis, Chief of the Bureau of Water, and he advises that it is correct. Referring to a picture of the pipe, he says the pipes removed are in perfect condition and a photograph would not show anything. The item follows:)

The city has saved $70,000 by digging up an abandoned pipe line and laying it in another location as a means of water supply, reports of Carleton E. Davis, Chief of the Water Bureau, to Director Caven, of the Department of Public Works, showed last week. The saving is on cast iron main 48 ins. in diameter.

The pipe was laid in 1888 between the old Spring Garden Pumping Station and the East Park Reservoir. It consists of four separate lines, and as Spring Garden Pumping Station, near the Girard avenue bridge over the Schuylkill river, was abandoned ten or twelve years ago, the pipes have been unused since that time. It was discovered that they are in good condition and after being cleaned and relaid will have an effective life over an indefinite period.

It was decided to put these pipes to use in relieving conditions in the lower end of West Philadelphia, where the population has increased rapidly and the demand for water has outgrown the existing facilities.

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Construction News and Equipment

CONSTRUCTION METHODS AND EQUIPMENT USED ON THE McMULLEN HIGHWAY NEAR CUMBERLAND, MARYLAND

By John N. Mackall, Chairman and Chief Engineer, Maryland State Roads Commission, Garrett Bldg., Baltimore, Md.

The construction of the McMullen Highway, running from Cumberland, Maryland, to the plant of the American Cellulose Company, 3.8 miles away, is of interest principally because of the difficult work encountered ,and of the equipment used. On the 3.8 miles of road, the excavation, almost entirely of shale, amounted to 95,410 cu. yds. Some of the cuts were as deep as 40 ft., and some of the fills as deep as 50 ft.

Three steam shovels were used in the cuts, and for the short hauls, an industrial railway was used, and for the longer hauls, horses and wagons. The large cuts were entirely of shale, so that it was necessary to shoot them in advance of the shovel. However, by using large and frequent charges of black powder, no difficulty was encountered in removing the material. One of the three shovels had a multipedal drag, and demonstrated its great superiority over the other shovels. It required no pit men, and was, of course, never off the track, never out of line and always ready to dig.

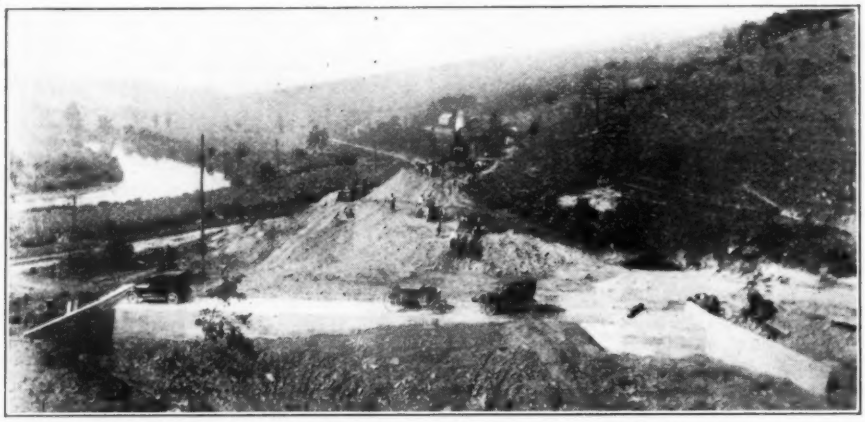
Robert Station, on the Baltimore & Ohio Railroad, was about midway of the job, and at this point, spur tracks were laid on a trestle, so that stone, sand and screenings could be unloaded by gravity. A cement house, large enough to hold a freight car, was built over the tracks, so that all cement could be unloaded indoors under any weather conditions. Space was provided for 2,000 tons of stone and 1,000 tons of sand which could be unloaded by gravity, and the batch boxes on the industrial railway used to transport this material to the mixer were loaded with a clam-shell bucket. The same crane or clam-shell could be used to repile the material after it was dumped from the cars, though this was never found necessary, due primarily to the shortage of cars for any form of transportation. The track was standard 24-lb. rail, 24-in. gauge, with plank ties. These plank ties were found much more satisfactory than steel ties, because they were wider, flat on the bottom, countersunk bolts being used to attach the rails to them, which permitted the track being laid to the finished concrete much earlier than it would have been possible with steel ties. After five days the track was shifted over on the concrete road. This expedited the work materially in that

CONSTRUCTING AN 18-FT. CONCRETE ROADWAY WITH AN INDUSTRIAL RAILWAY FOR HAULING MATERIALS TO MIXER, McMULLEN (MD.) HIGHWAY.

the track required no attention after it was moved up on the concrete, whereas it naturally required constant attention while it was placed on the shoulder.

Grades as steep as 6% were encountered, and it was found that the Plymouth engine used to pull the batch boxes could not handle these grades, and it was necessary to use a truck in addition to help up the heavy load. The batch boxes, on arriving at the concrete mixer, were dumped with the crane into the skip, and then from the skip to the mixer. This was found much more satisfactory than dumping the batch boxes directly into the mixer through the chute, because it distributed the load as it came into the mixer, and threw no undue loads on the mixer at any time.

With the amount of capital invested in plant and equipment, the progress of the work was not great. Some of this was caused by labor shortage, and some by the shortage of material. With a 21 cu. ft. Koehring paving mixer, for 1, 2, 4 mix, 18 ft. wide roadway, 6 and 8 ins. thick, the average for a number of days on which concrete was actually mixed was a little less than 190 ft. per day during 1919, and 170 ft. per day in 1920.



ONE OF THREE STEAM SHOVELS EXCAVATING MATERIAL FOR A 40-FT. FILL 250 FT. LONG, ON McMULLEN (MD.) HIGHWAY.

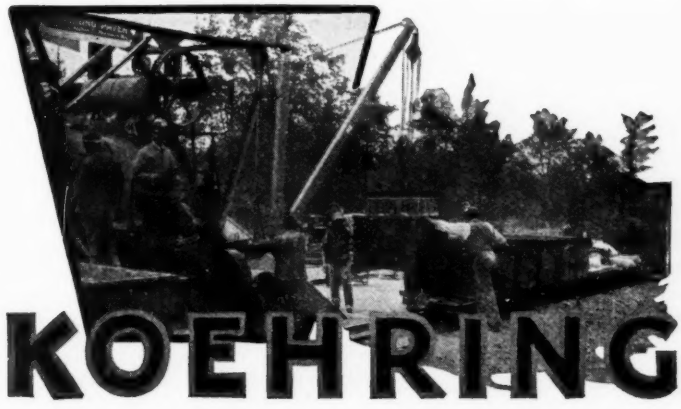
R. G. Collins, Jr., was the contractor on the work, and L. T. Downey was district engineer for the State Roads Commission, under whose direction the work was done.

THE NEW AUSTIN GASOLINE SHOVEL

The new Austin Model 6-T gasoline shovel is illustrated herewith.

This is not a makeshift adaptation of the steam shovel idea, but an entirely new

THE NEW AUSTIN GASOLINE SHOVEL.



KOEHRING

The Paver of Low Mixing Cost

EVERY second of time saving means money saving—profit making on a paving job. The paver that is lowest in cubic yard mixing cost is the cheapest mixer. Any other is costly.

Extra Yardage Built in

Koehring mixers *are designed* to give the lowest mixing cost. Centralized control—the many automatic actions found only on Koehrings enable the operator to maintain that day after day speed of operation which means a big season's extra yardage.

Heavy Duty Construction

Heavy duty construction is but another term for dependability—and dependability pays a big extra profit in trouble-free continuous operation—which means lowest mixing cost.

Koehring mixed concrete is dominant strength concrete.

Write for Koehring Paver Details

Koehring low mix cost—dependability—can't be wished into a mixer. It must be built in. It is built into Koehrings. Investigate. Write for details of Koehring pavers.

Koehring Machine Co.
MILWAUKEE, WISCONSIN.

KOEHRING SIZES
in cubic feet mixed concrete

Pavers: 10, 14, 21 and 28 cubic feet mixed concrete. Standard wet batch rating. Boom and bucket and spout distribution, steam and gasoline. Loading derrick, multiplane traction.

Construction Mixers. Sizes: 4, 7, 10, 14, 21, 28 cubic feet mixed concrete.

design, built "from the ground up" for gasoline operation.

Patented air-controlled clutches enable operators to manipulate the principal operations with ease, effectually removing the Austin 6-T from the hand-clutch, "man-killer" class. The cushion-drive clutches of swinging and crowding devices satisfactorily insure the necessary overlapping of operations. All operations may be quickly reversed at any time. The swinging machinery and hoisting drum are locked by means of automatic brakes when the power is shut off.

The increased earning power of the Austin 6-T shovel is apparent in the following exclusive features: Ease of control (not a man-killer); overlapping of crowd, swing and hoist; three-lever digging control; cushion-drive swing and crowd; automatic locking of swing and hoist; "slam the dipper" door (a clean dipper); power boom hoist; quick replacement of clutch bands; interchangeable clutch parts; complete accessibility.

CONTRACTOR SAVES $25,000 ON PAVING PLANT THEN ESTABLISHES NEW RECORD

R. P. Johnston, Superintendent of the Arthur McMullen Co., 149 Broadway, New York City, saved just $25,000 by careful planning of his paving plant on their contract for a reinforced concrete road near Siegfried, Pa.

SMITH SIMPLEX PAVING MIXER, SIZE 21-E ON CONCRETE ROAD JOB.

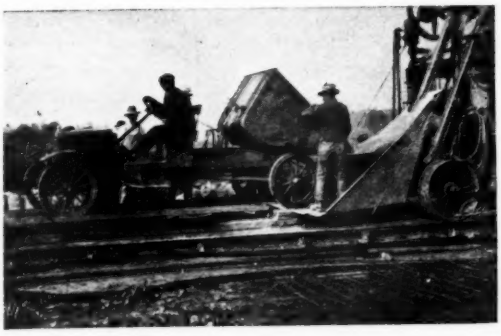
Not only was this important saving made, but the efficiency of his economical plant made it possible to establish a new production record for reinforced road work. On Oct. 18, 1920, in 9½ hours, working time, with a Smith 21-E boom and bucket paving mixer, the McMullen crew laid 576 lin. ft. of 18-ft. reinforced road, average thickness 7 1/3 ins.

The contract calls for 28,800 ft. of reinforced concrete road, 18 ft. wide, 8 ins. thick at the center, 6 ins. thick at the shoulder, or an average of 7 1/3 ins. The reinforcement is wire mesh, 25 lbs. to the square yard, placed 2 ins. below the surface. This specification requires practically two courses of concrete and naturally requires much more time than a non-reinforced road. Taking this into consideration, the 576-ft. record in 9½ hours, or 121 sq. yds. per hour, is remarkable.

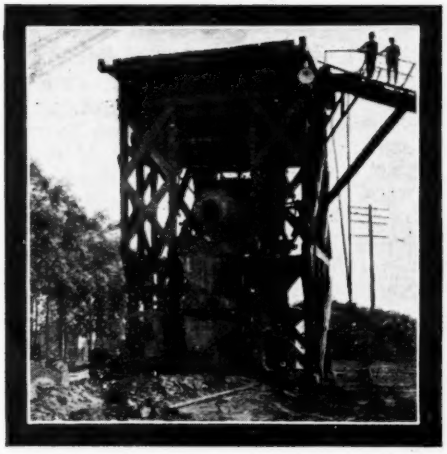
LIGHT TRUCKS TURNED ON A SIMPLE TURN-TABLE.

The proportion is 1:2:3, with 1¼-minute mix, operated under the batch meter, as per Pennsylvania specifications.

In planning his paving plant for this contract Mr. Johnston found that it would cost approximately $35,000 to install an adequate industrial railway system, as compared with an investment of only $10,000 in haulage equipment, including seven 1-ton dump body motor trucks. By



LIGHT TRUCKS WITH LEE BODIES DUMP AGGREGATE DIRECTLY INTO MIXER SKIP. WHEN PAVER MOVES TURN-TABLE IS MOVED WITH A TRUCK.



This Tilting Smith Central Mixing Plant made the 1920 road record for biggest daily production as well as biggest average production for the entire season.

Paving Mixer or Central Plant — Which?

Tilting Mixers
Non-Tilting Mixers
Paving Mixers
Excavator & Loader
Pumping Outfits
Construction Equipment

BE SURE you use the BEST equipment in the BEST manner. Determine first whether the Central Mixing Plant or the Paving Mixer will produce most under the conditions with which you must work.

By writing to us you can get in touch with the local Smith representative, who can discuss this thoroughly with you. Advice will be given impartially as to the method best adapted to your problem.

Smith Paving Mixers made the 1920 records for high daily and season's production. These records were established on both reinforced and non-reinforced concrete roads.

Smith Tilting Mixers, used as Central Mixing Plants, made the 1920 records for high production for one single day as well as for the season.

The single day's record does not mean so much. The record for the entire season means a great deal.

Find out about Smith Equipment—it represents Value that Endures.

Write also for "Smith Snapshots"—a valuable, high class magazine featuring profitable, speedy production in construction.

THE T. L. SMITH COMPANY

General Offices and Factories: 1180 32d Street, Milwaukee, Wis.
Eastern Office and Warehouse: New York **Western Warehouse: San Francisco**

placing his cement at convenient intervals along the roadway and hauling the sand and crushed stone for about a mile by these trucks, maximum results were obtained in a very simple manner.

The efficiency of the McMullen plant is further emphasized by the fact that the entire payroll, including every man on the job from loading bins to the road, on the 576-ft. record day, was only $331.71. This means that the labor cost per square yard was only 28 cts., which is remarkably low for this class of work.

The 1-ton dump body trucks haul the sand and crushed stone from the material bins, about a mile from the road work. The trucks are run onto a simply designed turntable which is kept just in front of the loading skip of the Smith paver. When the truck is turned the load is dumped and the cement added. This all has been planned so that there is no lost motion. The turntable is moved whenever the paver moves, merely by hooking it to one of the trucks and dragging it over the roadbed. This takes only a few seconds to replace the turntable, and it is usually not necessary to make a move more often than once for every 20 lin. ft. of road laid.

The Arthur McMullen Company has found that it pays to plan the entire paving plant carefully for both economy and efficiency.

WHAT IS THE OBJECTIVE IN A CONSTRUCTION CONTRACT?

By F. A. Wells, Vice-President and Treasurer, Wells Brothers Construction Co., Monadnock Block, Chicago, Ill.

(Editor's Note: This paper, by Mr. Wells, presented at the 1921 meeting of the Associated General Contractors of America, while pertaining directly to building construction, develops a viewpoint of interest to engineers and engineering contractors also.)

What is the best form of building construction contract? Is there a "best" form, taking into consideration the interests of all directly concerned?

Certainly there are forms of contract which any reputable architect, engineer or owner ought not ask a general contractor to sign. The government of the United States (unless it has altered its form recently), is the most notorious violator of equity in this matter. The postoffice in New Orleans was delayed 28 months by the government in order to make changes to suit altered conditions necessary to operation. The delay cost the general contractor many thousands of dollars. The Supreme Court, acknowledging the equity of the claim, said in its decision, that it could do nothing, its hands being tied because the form of contract, while unfair and inequitable, had been signed by the contractor.

The Real Objective

What, then, is the real objective in a construction contract?

1st: Is it to get a building for an owner at less than cost?

2nd: Is it to hedge a contractor about with such conditions that all incentive is taken from him, but that of trying to avoid the unfair conditions?

3rd: Is it to bind him by general and broad clauses to agree to do the impossible, and thus acknowledge before he starts the work of construction that he need not be treated as a man, but watched like a culprit?

4th: Is it to give the tricky, unreasonable contractor a chance to twist every clause in its interpretation so that he may avoid responsibility and increase profits?

5th: Is it to give the responsible contractor an opportunity to make the largest possible profit rather than produce a building for the owner at the most reasonable price? or

6th: Should the contract be of such equitable form that it will call out all that is best in the contractor and his organization and produce that co-operation between owner, architect, engineer and contractor, which can only result in a successful piece of construction as to economy in both time and money?

Contractor Responds to Confidence

I believe that a builder will demonstrate the most skill, integrity and efficiency when the owner, architect and engineer will trust him and express their confidence in a fixed fee form of contract.

I know this to be true in the case of our own company. We have operated exclusively on this basis for the past four years. We favor it so strongly that we take every opportunity to talk about it. There is something solid about the idea. It is not to be exhausted in a few words —the reason is, perhaps, that it is a step in evolution in form and method.

Mutual Confidence the Ideal Relationship

The Associated General Contractors should do more than merely watch the evolution of building contracts and the methods of building contractors. They do not evolve themselves. The associa-

tion can furnish the power to push energetically towards those forms which will draw out of the building fraternity the best there is in it. Many architects and engineers will unquestionably help to promote the more general use of the fixed fee building contract, but that will not be enough. We, as an association, are striving for higher ideals among our membership and fraternity. I know of no means whereby ideals can be uplifted so certainly as by having the owners trust us. When our association stands clearly for the skill, integrity and responsibility of the building industry, our members will have the confidence of the public as never before. The ideal relationship of architect, engineer, owner and contractor will then be possible, founded upon mutual confidence, and resulting in complete co-operation to produce the best structure.

Owners do not trust the contractor under a lump sum contract. They do not even trust him not to go "broke"—they exact a bond against that contingency.

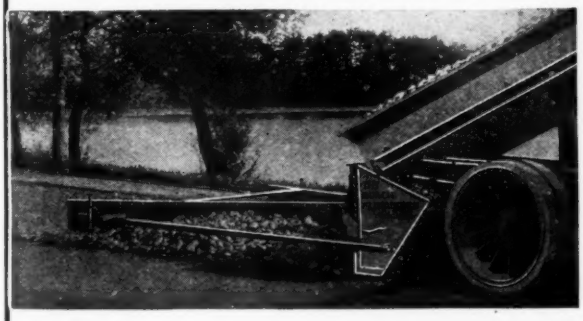
Some Architects Have Adopted Flat Fee Basis

Architects have always been trusted, being employed on a professional service basis. The great majority of them merit that trust, yet some among them have turned to a flat fee basis of remuneration in the belief that owners have greater confidence in their singleness of purpose under that plan. The temptation under the percentage fee plan to make the building cost a maximum is a real factor in the minds of many owners when making their decision. How much trust would an owner put in an architect who named a sum at which he would design and produce a certain building, taking as profit all the difference between actual cost and the named figure?

Architecture has been maintained as a profession, due in no small measure to the basis of charge for services rendered. Construction work, on the other hand, has been commercialized. Its doors have been opened so wide that the capable and responsible contractor has been put in competition with the careless, incapable and sometimes dishonest one, and the responsible bidder is often offered the contract at the irresponsible one's price.

Advantages of Fixed Fee Contract

Under the fixed fee contract method of engaging the builder all this is avoided, and the reputation, experience and responsibility of the builder will receive its just recognition.



SPREADS AS STONE IS UNLOADED

Eliminates the expense of stone spreading by hand—saves time, material and rehauling cost.

The Burch Stone Spreader is a machine that no road contractor can afford to be without. It will do the work of ten men and in much less time. It is attached in a minute to any size truck and spreads the exact amount of stone desired as it is unloaded.

THE BURCH STONE SPREADER

Can be adjusted to any width from 8 to 16 feet and any depth. It can also be adjusted to provide a crown for the road.

The Burch Spreader will save you enough in two miles of roadbuilding to pay for itself.

Write for complete information.

The Burch Plow Works Co.

Dept. G-2. Crestline, Ohio

THE SCOOP CONVEYOR

THOUSANDS IN USE

FOR STORING AND RECLAIMING
LOADING AND UNLOADING
CARS, TRUCKS AND WAGONS

SAVES 6 TO 12 MEN
SAVES CAR DEMURRAGE

ELIMINATES SHOVEL AND WHEELBARROW WORK

KEEPS EQUIPMENT MOVING

WRITE FOR CATALOGUE

PORTABLE MACHINERY CO., PASSAIC N.J.

What Do You Want to Buy?

If you want to be relieved of the annoyance of extensive correspondence and calls from salesmen who do not understand your needs, just write a brief letter to us stating your requirements and we shall immediately place you in touch with the manufacturer best qualified to serve you.

Municipal and County Engineering

538 S. Clark St. Chicago, Ill.

By the latter method, building construction becomes a profession; but not where the spirit of trust is lacking, not where the owner, his architect and engineer are constantly watching that the contractor does not gouge by inferior work or by an unconscionable price for extras and changes; not where the interests of owner and contractor are diametrically opposed so that a decision in favor of one must of necessity be unfavorable to the other. Rather does it become a profession when owner and architect seek a responsible builder of known integrity and entrust the work to him, satisfied that the builder will exercise all the skill and integrity of his organization to make a creditable building, on time and at the least possible cost commensurate with quality.

Shall we not accept the suggestion of some leading architects who have gone from percentage fee to fixed fee for the architect's services in order to win more owner confidence? Will not the owner and all who serve him be benefited by changing from the lump sum form of contract for construction to the fixed fee basis of remuneration for the builder's services? In our opinion, the building industry will make its greatest advance when we seek the confidence of owner, architect and engineer, and then justify that confidence.

This, then, is why I plead for the fixed fee form of contract. I believe it accomplishes the two most important objectives:

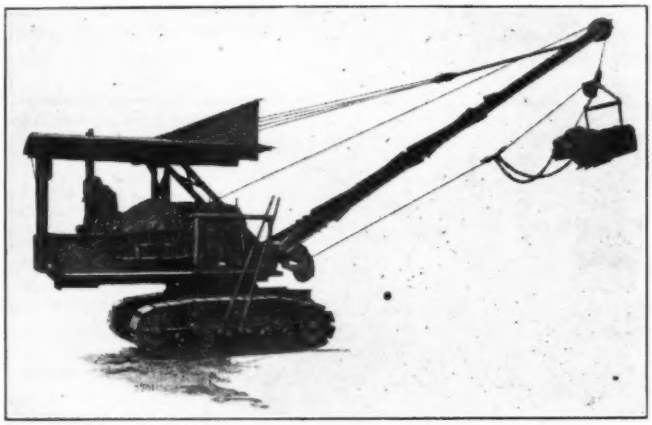
First: It will attract to the construction industry men of integrity, capability and responsibility. When this has been fully accomplished, the second objective will be realized.

Second: It will produce for owner, architect and engineer the best possible building for the least possible cost in the shortest period of time commensurate with quality; all made possible because the builder shares their interests under the fixed fee form of contract.

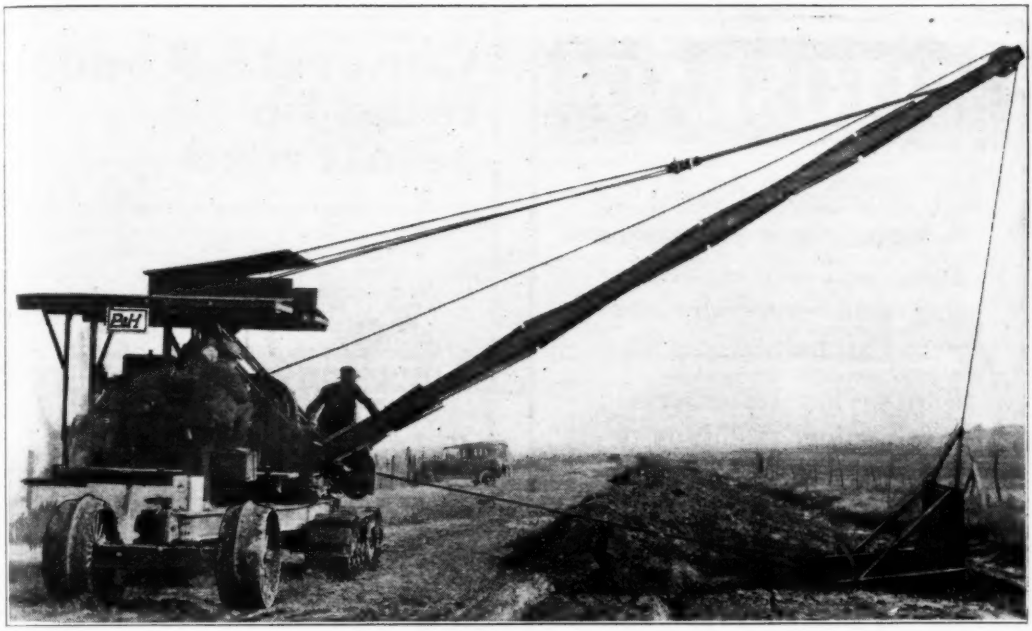
The objective of the Associated General Contractors must be to place general contracting as a whole on the highest possible plane of responsibility. We must not be the three-ball depository of the gains of the "artful dodger," but the national banks of integrity and ability to which owners can come with confidence when they need to draw upon our services.

NEW P. & H. EXCAVATOR CRANE

As a further development of its excavating machinery, and as an addition to P. & H. Excavator-Cranes, the Pawling & Harnischfeger Co., of Milwaukee, has brought out its No. 206 machine, which is a heavy duty, large capacity excavator of the full tractor type. As on the 205 crane, the corduroy traction consists of 20-in. wide cast steel treads. The sprockets which are placed on 9-ft. centers, are of manganese steel, bronze brushed, and adjustable to take up wear. The short turning radius gives it extreme ease of handling, a complete turn in twice its width being possible. Because no leading wheels are used, as on 205, this crane has a still larger radius of operation, getting into locations and



THE NEW P. & H. EXCAVATOR—CRANE NO. 206.



P & H 205 Excavator-Crane with Scraper Bucket.

One Man and a P & H

The many kinds of work that one man and a P & H Excavator-Crane can do, and the speed of doing them, always attracts attention.

These portable general utility cranes can be taken from one job to another—set to digging with clamshell or digging bucket; tearing up roads; grading; shouldering-up; cleaning out ditches; back-filling; loading, handling and unloading sand, gravel and other materials; and even driving piles.

NEW BULLETIN 5X (January, 1921) NOW READY

In this new edition complete specifications are given and many photographs taken in the field are reproduced. Send to Publication Department for a copy.

PAWLING & HARNISCHFEGER CO.

EXCAVATING MACHINERY DIVISION

In Milwaukee Since 1884

New York	30 Church Street
Philadelphia	Stephen Girard Building
Pittsburgh	Fidelity Building
Chicago	Monadnock Block
New Orleans	Whitney Central Building
San Francisco	Monadnock Building
Los Angeles	Central Building
Seattle	L. C. Smith Building
Portland	Yeon Building
Birmingham	C. B. Davis Engineering Co.
St. Louis	Blackman-Hill-McKee Machinery Co.
Salt Lake City and Denver	Landes & Co.

P&H Excavator-Cranes

BITOSLAG

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AN improved asphaltic concrete pavement composed of finely ground slag and especially prepared asphalt.

Bitoslag has demonstrated in practice that it is designed to meet all the demands of modern traffic.

Write for descriptive matter.

Bitoslag Paving Co.

90 West St., New York, N. Y.

Concrete Roads must be reinforced

It is demonstrated beyond doubt that to make concrete roads proof against heavy motor traffic, weather and time a fabric of steel must be incorporated in the concrete.

Several great States have so ruled.

American Steel and Wire Company's

Concrete Reinforcement

Fulfills every engineering requirement.

Send for our book on road building.

CHICAGO
NEW YORK
CLEVELAND
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DENVER

PIONEER Highest Quality ASPHALTS

"PIONEER"

Highest Quality Asphalts

Any Melting Point, Any Ductility, Any Penetration

We are Asphalt Specialists, and there is now a PIONEER product complying with practically every Asphalt or Bituminous specification. Let us quote you on your requirements.

OUR POLICY: "A personal interest in every order; an earnest endeavor to please."

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Ruberoad Cement

It's New It's Different It's Efficient

A product that will interest every engineer and contractor; especially made and adapted for repairing cracks in concrete roads and pavements.

THE PIONEER ASPHALT CO.

LAWRENCEVILLE, ILL.

SPRINGFIELD PAVING BRICK

ARE WIDELY USED

Springfield Paving Brick Company

SPRINGFIELD, ILLINOIS.

over uncertain soil as rapidly as the now famous tanks did in Europe.

Two traction speeds are provided, one for moving from one location to another over roads or good earth surface, and a lower speed to be used when soft or extremely hilly surfaces are encountered, and when coming out of deep ditches. The power plant consists of a 4-cylinder Waukesha heavy duty motor, 50 h.p., Warner Vacuum feed, so that fuel is supplied the engine regardless of position of the crane; and a storage tank carried below at rear sufficient to provide for about 20 hours' continuous operation. For use with a ¾-yd. bucket, a 30-ft. boom of braced structural steel is furnished, or a 38-ft. boom for a ½-yd. bucket—drag line or clam shell. Backfiller, lifting magnet, or slings may replace the bucket for filling or material handling duties.

All operating levers are located convenient for one operator on the right side, as shown in the accompanying illustration, giving him complete control of all movements and operations.

Contracts Awarded

ROADS AND STREETS.

Ala., Lauderdale—Wm. T. Taylor Constr. Co. awarded contract by State Hwy. Dept. to construct 12 miles of road in Lauderdale county, at $156,885.

Ala., Montgomery—W. T. Taylor Constr. Co., Wilsonville, awarded contract for grading and installing draing. structs. on 18.2 miles F. A. Proj. 88, 24 ft. wide, at $126,814.

Ark., Springdale—Mayme Bros., Oklahoma City, awarded contract for construction work in Road Dist. No. 5, Benton county, at $194,000.

Ark., Bentonville—A. A. Davis Contracting Co., Oklahoma City, awarded contract by Benton Co. Commrs. Rd. Impvt. Dist. No. 6 for construction of 30.31 miles of road, including steel bridges, at $127,387.

Cal., San Diego—Geo. R. Daley, 440 McNeece Bldg., San Diego, awarded contract for paving with concrete 4.73 miles county highway between Escondido and San Marcos, at $112,681.

Cal., Santa Ana—Steele Finley, Santa Ana, awarded contract for resurfacing 9 miles Garden Grove avenue, West Fifth street, Anaheim, Cypress and Anaheim Olive roads, 2-in. asphalt, at $75,248.

Colo., La Junta—G. A. Dalgren, West Third street, awarded contract for paving roads in Paving District No. 1, at $122,272.

Fla., Titusville—Snyder, Mott & Co., West Palm Beach, Fla., awarded contract to construct 19-mile (Rd. and Bridge Dist. Cocoa Beach); ojus rock and asph. treat.; $170,000 available.

Ga., Athens—Hagedorn Constr. Co., Montgomery, Ala., awarded contract to construct concrete pavements on Danielsville-Athens and Lexington-Athens Rd.; 5.44 miles, concrete with stone aggregate; $160,000.

Ia., Sibley—J. S. McLaughlin & Sons, Mankato, Minn., awarded contract for 80,000 yards paving, at $350,000.

S. C., Rock Hill—Ely Constr. Co., Augusta, Ga., awarded contract to pave streets; 130,000 sq. yds. sheet asphalt on concrete base; 90,000 1 in. ft. curb and gutter; $100,000.

Kans., Columbus—Koss Constr. Co., 2818 Fifth street, Des Moines, Ia., awarded contract for paving 2.95 miles Joplin and Galena roads, F. A. Proj. 71, Sec. A, 18 ft. wide, conc., at $138,580.

Kans., Columbus—Joplin and Salina Road Comm. awarded contract for improving and building bridges on 2.95 mi. Sec. A, Spring Valley, at $139,-580.

La., Arcadia—Smith Bros., Alexandria, La., awarded contract to construct 70 miles gravel road; $1,500,000 available.

La., New Orleans—State Hwy. Dept. let contracts for building 5.21 miles Tallulah-St. Joseph Hwy., Sec. A, Madison Parish, to S. K. Jones, 1252 Herbert avenue, Memphis, Tenn., at $34,968; 21.11 mi. Rayville-Monroe Hwy., Sec. A-1, Richland Parish, to J. M. Bass & Co., Hazelhurst, Miss., at $18,558; 13.26 mi. Rayville-Winnaboro Hwy., Sec. C, Richland Parish, to A. E. Perry, Colfax, at $158,471; 17.37 mi. Arcadia-Shreveport and Arcadia-Ruston

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Concentrate upon your Work. One Filling and

The „Minerva" Fountain Ruling Pen

is set for a whole day's requirement. Use any ink—will not leak or clog.

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KOLESCH & COMPANY

138 Fulton Street **NEW YORK**

Hwys., Bionville Parish, to W. H. Smith, Alexandria, at $331,903.

Mich., Lansing—L. W. Edison, Rogers, Mich., and Traverse H. Duvall, Bain, Mich., awarded contracts by State Hwy. Dept., at total of $133,312.

Mich., Lansing—Beaverton Constr. Co., Beaverton, Road 18-14, Midland county, awarded contr. for grading and draining structs., 2,038 miles, at $13,054; Hilland Fuller, Big Rapids Rd. 24-3, Newaygo county, B-gravel base, 16 ft., 3,006, at $15,-998; J. Albert Swanson, Leroy, Rd. 63-2, Oscola county, C-slag gravel road, at $43,200; Lake Co. Rd. Comn., Baldwin, Rd. 63-3A, Lake county, stocking gravel, at $11,616; Ann Arbor Asph. Constr. Co., Ann Arbor, Rd. 65-3B, Livingston county, B-gravel road, 5.625 miles, at $71,778.

Minn., Duluth—D. H. Clough & Co. awarded contract for paving and improving Superior street, Twenty-third to Thirty-ninth streets, at $257,023.

Mo., Greenville—Wayne County Court, Greenville, awarded contract by State Hwy. Dept. for building 14.38 mi., Sec. A, Piedmont-Marble Hill Rd., F. A. P. 129, Wayne county, at $146,072.

Miss., Canton—B. F. Stroud, Durant, Miss., awarded contract for construction of important link in Jefferson Davis National Hwy. through Madison county, 9.8 miles. Work will cost approx. $75,000.

Mont., Whitehall—T. T. Black awarded contract for grading road through Cottonwood Canyon, at $80,000.

N. J., Belvidere—Masterton Constr. Corp., 15 East Fortieth street, N. Y. City, awarded contract for grading Hope-Blairstown road, Hope and Blairstown townships, at $109,365.

N. M., Clovis—Clark & Henery Constr. Co., Hearst Bldg., San Francisco, awarded contract for paving portion of 5 city streets with 5-in. Warrenite-Bitulithic, at $180,440.

N. M., Santa Fe—State Hwy. Comn. let contract for constructing 17.98 mi., Road F. A. P. 22, Gaudaloupe county, and 13.825 mi., F. A. P. 28, Grant county, to LaRoe, Palestine, Texas, at $132,401, and $214,090, respectively; 8.747 mi. rd., F. A. P. 23, De Baca county, and 15.981 mi. rd., F. A. P. 43, Torrance county, to J. V. Stryker Constr. Co., Denver, at $13,673 and $19,853, respectively.

N. C., Kinston—West Constr. Co., Chattanooga, Tenn., awarded contract to construct hard surface roadway; $2,000,000 work involved; $700,000 available.

N. C., Newton—Geo. R. Martin, Salisbury, N. C., awarded contract for impvt. of streets; hard conc. surface; 40,000 sq. yds., curb and gutter; $100,000 available.

O., Canton—Stark County let following contracts: Paving 2.75 mile Massillon-Orville Rd., 15 ft. wide, brick and gravel base, macadam shoulder and asphalt filler, to E. Vogt, Massillon, at $126,112; 2 mi. Sec. B, Hartville-Marlboro Rd., 16 ft. wide, macad. with asph. binder, to P. Christianson, 1355 Yale avenue, N. W., Canton, at $70,155; 1.04 mi. Canal-Fulton-N. Lawrence Rd., 14 ft. wide, brick on gravel base, slag shoulder and asph. filler, to W. G. Myers, Canton, at $49,872; 1.69 mi. Sec. A, Marlboro-Hartville Rd., 16 ft. wide, brick with slag base, tar filler and conc. curb, to G. Hadley, Salem at $99,253; 1 mi. Strausberg-Beach City Rd., 14 ft. wide, brick with comb. conc. base and curb, to Wise Bros. Co., Canton, at $24,000.

O., Columbus—R. B. Sheridan, 500 Grand Theatre Bldg., awarded contract for paving 2.02 miles Sec. P, Columbus-Sandusky Rd., 50 ft. wide, Franklin county, brick, at $238,943.

O., Columbus—State Hwy. Dept. let contracts for grading, building bridges and culverts and paving roads as follows: Williams Co., Sec. "Stryker" Bryan-Wauseon Rd., 1.393 mi., bitum. conc., to A. Langenderfer, Toledo, at $104,197; Wyandotte Co., Sec. "L," Marion-Upper Sandusky Rd., 3.56 miles, asph., conc. or conc. base, to H. P. Streicher Co., 310 Terminal Bldg., Toledo, at $175,997.

O., Columbus—Brown & Cook, Lancaster, O., awarded contract for improvements in Muskingum county, on Sec. F-1, Zanesville-New Lexington Rd., 3.15, at $174,991.

O., Dayton—G. Hoolihan awarded contract for paving 1.7 miles Troy Pike-Vandalia southward, at $90,881.

Okla., Claremore—Stanton & Ammerman, Leavenworth, Kans., awarded contract for paving, curbing and guttering Districts 4 and 7, involving 70,000 sq. yds. asph. conc., at about $400,000.

Okla., Eufaula—A. A. Davis, Oklahoma City, Okla., awarded contract to construct 23 miles Jefferson Hwy. through McIntosh county; gravel; at $354,427.

Okla., Idabel—S. B. McCartney, Valiant, awarded contract for 11.8 miles graded earth road, F. A. Proj. No. 2, at $117,000.

Okla., Oklahoma City—State Hwy. Dept. let following road contracts: Western Pvg. Co., $128,747, Sec. A, s. of Normal Rd. to Cleveland county line; Allen & Harrison, $165,033, 1st sec. east from Oklahoma City; $154,725, Sec. C, M. A. Swatek & Co.; $138,793, Sec. D; construction will be carried on in spring and summer.

Okla., Tulsa—Max J. Cunningham awarded contract for remainder of the "Big Four" paving contract. Contract calls for approx. 4 miles concrete surfaced highway 9 miles southwest of Tulsa, on Bixby Rd., at cost of $103,399.

Okla., Tulsa—Standard Paving Co. and Parker-Washington Paving Co. awarded contracts to resurface First street, east and west of Main, at $100,000.

Okla., Oklahoma City—A. A. Davis & Co., Oklahoma City, awarded contract for grading, constructing drainage structs. and gravel surfacing on Jefferson Hwy. through McIntosh county, about 21 miles, at $356,000.

S. C., Rock Hill—Ely Constr. Co. awarded contract for paving various streets, 3-in. sheet asph. on 5-in. concrete base, at $100,000.

S. D., Hot Springs—W. H. Butler, Sturgis, awarded contract by St. Hwy. Dept. for grading, draining and graveling 5.509 mi. Hot Springs-Oelrichs Rd., 36 ft. wide, F. A. P. 59, Fall River county, at $137,508.

S. D., Rapid City—Peterson, Shirley & Gunther, 1217 Woodmen of the World Bldg., Omaha, Neb., for grading and constructing draing. structs. on Custer-Hermosa-Rapid City Rd., 36 ft. wide, F. A. P. 70, Custer county, at $71,300.

Tenn., Nashville—T. L. Peters & Co., Knoxville, awarded contract for paving and building 2 bridges on 12.76 miles State Hwy. between Knoxville and Loudon county line, rock asph., F. A. P. 41, Knox county, at $434,999; 15.38 miles State Hwy. between Fayetteville and Bedford county line, asph. macadam, F. A. P. 50 Lincoln county to B. Williams, 821 Broad street, Nashville, at $488,831.

Tex., Canadian—Hemphill Co. let contract for grading, surfacing and draining 13.44 miles State Hwy. 4 from here to Lipscomb county line, 16 ft. wide, to J. F. Hamer, Stop 6, Interurban, Ft. Worth, at $90,530; including 10 per cent for engrg. and contingencies.

Tex., Dallas—Texas Bitulithic Co. awarded contract for paving Junius street-College avenue to Fitzhugh avenue, at $94,602.

Tex., El Paso—Lee-Moor Contg. Co., Two Republic Bldg., awarded contract for 12.6 miles, Hwy. No. 1 (Fabens Road), bitum. conc. paving, at $380,-903.

Tex., Hillsboro—Brown & Root, Taylor, awarded contract for grading, surfacing with gravel and constructing draing. structs. on Irene-Mertens and Irene-Corsicana Rds., in Irene Special Rd. Dist. No. 8, at $64,270.

Tex., Jasper—H. F. Bland awarded contract for hard surfacing roads; $135,000 available.

Tex., San Antonio—Southwest Bitulithic Co. and Uvalde Co. awarded contracts for 51,000 sq. yds. paving at est. cost of $163,198.

Tex., San Antonio—Paul W. Lane awarded contract to pave streets here, at $5,670; Southern Bitulithic Co. and Uvalde Rock Asph. Co. awarded contracts to pave streets (51,100 sq. yds.), at $163,-198.

Tex., Seguin—Paul Schriever awarded contract to construct draing. structs. on Highway No. 3, at $71,883.

Wash., Aberdeen—Grays Harbor Constr. Co. Aberdeen, awarded contract for widening fill from 24-32 ft. on Simpson avenue and paving 21 blocks Simpson and Park avenues, 36 ft. wide, at $136,740.

Wash., Seattle—Jahn & Bressi awarded contract for paving on Nickerson street, at $84,092.

Wash., Seattle—D. H. Traphagen, Walker Bldg., awarded contract for clearing, grading, curbing and bldg. walks on Wilson Ave., et al; also grading and curbing W. 59th St., et al, at $90,293 and $16,-176, respectively; J. B. Cavello, Seattle, contract for curbing, paving and bldg. walks on 33rd Ave. S., et al, at $25, 647.

Wash., Seattle—J. L. Smith, awarded contract for grading and curbing 15th Ave. W., at $99,312.

Wash., Seattle—Jahn & Bressi, awarded contract for grading and constructing sewers, etc., on Elliott Ave., et al, at $190,252.

Wis., Elkhorn—R. R. Birdsall Constr. Co., Racine, awarded contract for grading and paving Delavan-Lake Geneva Rd., at $85,169.

Wis., Juneau—Ed L. Bartlett, Watertown, awarded contract for F. A. P. 72, Co. Line Rd. betw. Dodge and Jefferson Cos., at $141,914.

SEWERAGE AND SEWAGE TREATMENT

Cal., Calipatria—E. L. Plantico, 4120 Central Ave., Los Angeles, awarded contract at $9,554 for constr. of lat. sewers.

Cal., Huntington Beach—Mlagenovich & Gillespie, 1039½ W. 36th St., awarded contract for constr. of about 17,750 ft. 8-in. vitr. pipe sewer, 45 manholes and 9 flush tanks, at $17,750.

Cal., Los Angeles—Leo Miletich, 610 W. 54th St., awarded contr. for vitr. pipe sewer in Serrano Ave., at $523; B. Deragno, 1614 S. Hill St. contract for cem. pipe sewer in Vendome St., at $2,467; Adam Dalmatin and Mike Guho, 818 E. 40th St. awarded contract for cem. pipe sewer in Armandale Ave., at $14,900.

Cal., Selma—Harron & Hays, Los Angeles, awarded contract for extension of sanitary sewerage system, at $90,000.

D. C., Washington—Warren F. Brenizer Co., 101 New York avenue, awarded contract to construct 700 ft. 15-in. diam. pipe and 350 ft. 12-in. diam. pipe outlet sewers on Nebraska avenue and Broad Branch Road, at $3,500.

D. C., Washington—Warren F. Brenizer Co., 101 New York avenue, N. E., awarded contract to construct 700 ft. 9 ft. x 16 ft. 9-in. conc. sewers, at $8,400.

Ill., East Moline—National Constr. Co., Davenport, awarded contract to construct big sewer here. Contractors will do as much work on the sewer this winter as possible.

Kans., Emporia—C. H. Everett, Hutchinson, awarded contract to construct south side sewer, at $29,336.

Mich., Detroit—Booth & Flinn, 17 Battery Place, New York City, awarded contract to build 6,914 ft. tunnel sewer in Bates, Congress, Madison and Brush streets, at $1,638,290.

Minn., Hibbing—Schirmer Bros., Hibbing, awarded contract for sanitary sewer at new high school building, at $8,014.

Minn., Little Falls—City will construct trunk sewers in District No. 2, involving 5,250 ft. 15-20 in. pipe, 13 manholes, 330 ft. 8 in. vitr. pipe connections, etc. Work will be done by day labor.

Mo., Joplin—City will construct by day labor, under supervision of O. P. Mahoney, St. Commr., City Hall, 5 miles conc. sewer in Shoal Creek and Chetwood sewer projects. About $291,500.

Mo., Joplin—Ozark Paving Co. awarded contract for sewers in Villa Heights, at $12,426; Henry Kost, contr. for Castle Rock sewers, at $7,739.

Mo., Joplin—City will construct 5-mile concrete sewer in Shoal Creek and Chetwood sewer projects by day labor, under supervision of O. P. Mahoney.

Mo., Springfield—Plummer-Adams Constr. Co. awarded contract to construct sewers in District 9; lay 25,230 ft. 8-in. vitr. sewer pipe, including 87 manholes, 8 flush tanks and lampholes—total cost, $41,322.54.

Mo., Springfield—Ralph Langston awarded contract to lay 25,230 ft. 8-in. vitr. sewer pipe, including 87 manholes, 660 yards, 8 flush tanks and lampholes; $43,596.

Mo., Springfield—John Spandri awarded contract to construct sewer system in District No. 36, at $9,873.

N. Y., Brooklyn—Rosenthal Engrg. & Contg. Co., 326 Jackson avenue, awarded contract for repairing rein. conc. sewer in Maspeth avenue, Porter avenue to Newtown Creek, at $132,347.

N. Y., New York City—Melrose Constr. Co., 103 E. 125th street, New York, awarded contract for constr. of 18-in. cast iron pipe drains in West street, at $10,740.

N. Y., Ossining—Carroll Contracting Co., Inc., 103 Park avenue, New York City, awarded contract for building sewerage and water supply system here, at $313,392.

N. Y., St. George, S. I.—Richfield Constr. Co., 280 Madison avenue, New York City, awarded contract for building temporary sanitary outlet sewer in Cromwell avenue, etc., at $51,968.

O., Akron—Crano, Darrow & Lombardi awarded contracts for sewers on Bye street, at $31,791; D. E. Beattie Co., contract for sewer on Maple street, at $30,604.

O., Euclid—Village let contracts to A. Marra, Illuminating Bldg., Cleveland, for building sewers and water mains in Chatworth Dr., at $14,803; Argyle Dr., $4,892; Oakhill Dr., Glenwood Blvd. to westerly end, at $9,792; Curro Bros., 1206 Mayfield Rd., Cleveland Glenbrook Blvd., at $14,347; Hawthorne Dr., $5,015; Yosemite Dr. from Beverly Hills to Argyle Dr., $5,370; Idlehurst Dr., $11,053; Hadded-Mall Co., Schofield Blvd., Cleveland, Bev erly Hills Dr., at $14,654.

O., Greenville—W. J. Irwin & Son, local, awarded contract at Mansfield, O., for sewer at $32,000, and contract at Lima, O., at $200,000.

Okla., Miami—James & Show, Miami, awarded contract for installing outfall sewers and disposal plant, at $151,000.

Pa., Erie—E. G. Diefendorf awarded contract for 3 new sanitary sewers, as follows: Thirty-third street and Old French Rd., $4,589; Twentieth street, both sides of Brandes street, $916; Old French Rd. and Market Lane, $3,417—all 9-inch.

S. D., Sioux Falls—Fanebust Bros., Sioux Falls, awarded contract for sewer in Eighth street, south from Weber avenue to Indiana avenue, at $14,756.

Tex., Austin—C. H. Foley, 1639 Elizabeth street, Wichita Falls, awarded contract for building storm sewers in 4, 5, 6, 7, 10, Travis, Austin, Indiana and Ohio streets, involving 8,450 ft. segmental and 9,327 ft. tile blk. pipe, at $200,885.

Tex., Eastland—James Constr. Co. awarded contract to extend sewer system in Daugherty avenue south of Sadosa street, and Burkett, Harrell-Sikes and Chastain Addns., disp. plant on Leon River; build additional storm sewers costing $185,000.

Tex., Ft. Worth—Dwight P. Robertson & Co. awarded contract for construction of sewage disposal plant, at $800,000.

Tex., San Antonio—McKenzie Constr. Co., San Antonio, awarded contract for constr. of storm sewers on Indianola street, at $57,000.

Tex., Wichita Falls—C. R. Nicholas, Wichita Falls, awarded contract for building sanitary sewerage system, at about $700,000.

Wis., Elkhorn—D. P. Cayll, Main street, Waukesha, awarded contract for excavating and laying 9 miles 8-10 vitr. sewers, etc., in Wisconsin street, at about $20,000.

Wis., Ft. Atkinson—G. W. Leisman, 313 Grant street, awarded contract for excavating and laying 8,700 ft. 8-10 in. vitr. pipe sewer and building necessary manholes in Main street, at about $25,000.

WATER SUPPLY AND PURIFICATION

Ariz., Tucson—Littlejohn & Singleton, Tucson, awarded contract for building concrete storage reservoir and 4 culverts, at $36,400.

Ala., Montgomery—Layne-Bowler Co., Memphis, Tenn., awarded contract to drill 4 artesian wells with daily supply of 6,000,000 gals., at $110,000.

Cal., Glendale—Peter L. Ferry, 614 E. Acacia street, Glendale, awarded contract for constructing a reinf. conc. reservoir with wood roof supported by wood posts for city water works, at $60,800. Contract involves about 18,900 cu. yds. excav. and 214,331 sq. ft. 4-in. reinf. concrete lining; Los Angeles Mfg. Co. awarded contract for furnishing and laying 5,000 ft. 3-16-in. riveted steel pipe in Glendale avenue, and contract at $1,503 for furnishing and laying 1,800 ft. 14-gauge 6-in. riveted steel pipe in roadway.

Cal., Hemet—Bent Bros., Central Bldg., Los Angeles, awarded contract by Hemet Water Co. for lining two 100x200 ft. tunnels with concrete and building two rein. conc. pipe syphons, one 433 ft., 39 in. long, the other 1,050 ft., 42 in. long, at about $20,000.

Cal., Sacramento—Commr. Pub. Wks. is considering awarding contract to California Filter Co. for supplying city with chlorine for treatment of water pumped from river during 1921. The chlorine in 12-cylinder lots would cost 19½c.

Cal., San Bernardino—American Cast Iron Pipe Co. awarded contract for furnishing Water Comn. with 3,200 ft. 3-in. pipe and 700 ft. 4-in. pipe, at about $5,000.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Barber Asphalt Co.
Bitoslag Paving Co.
The Barrett Co.
New Orleans Refining Co.
Pioneer Asphalt Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
Barber Asphalt Paving Co.
The Barrett Co.
Bitoslag Paving Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
Barber Asphalt Paving Co.
The Barrett Co.
Sinclair Refining Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Railroad Plants.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Surface Heaters.
Barber Asphalt Paving Co.

Asphalt Tools.
Barber Asphalt Paving Co.
Warren Bros. Co.

Asphalt Tool Wagons.
Barber Asphalt Paving Co.

Auto Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Co., The
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Barber Brand Cold Repair Cement.
Barber Asphalt Paving Co.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Bermudez Road Asphalt.
Barber Asphalt Paving Co.

Binders, Road.
Barber Asphalt Paving Co.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.
Pan-American Bridge & Construction Co.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Pawling and Harnischfeger.

Buckets, Grab.
Mead-Morrison Mfg. Co.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement, Portland.
Portland Cement Association.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Lakewood Engineering Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Concrete, Tanks.
Mensch, L. J.

Conduits.
Cannelton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Samuel A. Greeley.
Hill & Ferguson
Howard, J. W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Shields, W. S.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Lakewood Engineering Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Crushed Stone.
Cleveland Stone Co., The

Culvert Molds.
Austin-Western Co., Ltd., The
Storms Mfg. Co.

Culvert Pipe, Cast Iron.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Curbing, Sandstone.
Cleveland Stone Co., The

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Can., St. John, N. B.—Water Power Comn. let contracts for furnishing hydraulic machinery to Morgan Smith Co., St. John, at $93,056; elec. machinery to Canadian General Electric Co., 107 Park street, Peterboro, at $162,000.

Conn., Hartford—A. C. Sternberg, West Hartford, awarded contract for furnishing and placing filter sand in filter bed, at $63,000.

Ia., Mason City—City will build by day labor new reservoir and wells; also will deepen present wells. Work will cost about $300,000.

Ky., Covington—Worthington Corp., Clinton and Roberts streets, Buffalo, awarded contract for building 10,000,000-gal. pump for water works, at $996,000; furnishing 309 hp. boiler for water works plant at Fort Thomas to D. Connelly Boiler Co., at $12,559.

Mass., Dorchester—Simpson Dry Dock Co., Marginal street, East Boston, awarded contract for furnishing and installing pumping engine 5 at Calf Pasture Pumping Station, at $78,453.

Mass., Fall River—R. H. Beattie, Buffington Bldg., awarded contract by Quequechan River Comn., City Hall, for building substructure for sand bar dam and foundation for pumping station, at $87,209.

Mich., Detroit—Water Board will lay 15,670 ft. 6 and 8-in. cast iron water mains in various thoroughfares; also 3,050 ft. 24-in. mains in Van Dyke avenue. Work will be done by day labor.

Pa., Philadelphia—Pittsburgh-Des Moines Steel Co., 30 Church street, New York City, awarded contract for water storage, High and Curbey streets, Philadelphia, for John Bromley & Sons, Inc., at $17,000.

Pa., Philadelphia—R. D. Wood & Co. awarded contract for furnishing cast iron water pipe and castings, at $70,000.

Tenn., Manchester—J. B. McCrary Engineering Co., Third National Bank Bldg., Atlanta, awarded contract for constructing water works system, involving 60,000-gal. reservoir tank, 250-gal. per min. pump and 20 hp. oil engine, at $40,000.

Tex., Dallas—City will lay water mains in various streets and avenues. Estimated cost of work about $80,000. Day labor.

Tex., Plainview—Irick & Bowden, Plainview, awarded contract for extending water mains in various streets, at about $70,000.

Prospective Work

ROADS AND STREETS

Ala., Montgomery—State Hwy. Comn. having plans prepared for grading, draining and surfacing 26.27 miles Geneva-Enterprise-Elba Rd., 24 ft. wide, sand clay, Coffee county, $158,022; 16.94 mi. Abbeville-Eufaula Rd., Abbeville to Barbour line, 24 ft. wide, sand clay, Henry county, $234,278; 20.52 mi. Brewton-Bay Minette Rd., from Brewton to Sardis Church, 24 ft. wide, gravel, Escambia county, $359,707; surveys being made for 23 mi. Tuscaloosa-Fayette Rd., Tuscaloosa to Fayette county line, 24 ft. wide, gravel, Tuscaloosa county; 12.3 mi. Camden-Greenville Rd., Camden to Butler county line, 24 ft. wide, sand, clay or gravel, Wilcox county; 15.5 mi. rd. from Limrock to Madison county line, 24 ft. wide, Jackson county. W. S. Keller, State Hwy. Engr.

Ala., Tuscaloosa—Tuscaloosa Co. Commrs. will construct 25.22 miles of road from Northport to New Livingston, known as Byler road; gravel surfacing; $515,545.

Cal., Palo Alto—City will receive bids about March 1 for grading, paving and laying storm sewers in 2.8 miles Forest avenue, Alma, Emerson, Cowper and Middleford streets, involving 59,680 sq. yds. 5-in. conc., 6,220 lin. ft. curbing, 6,000 sq. ft. walks, 10,250 cu. yds. excav., 36 catch basins, 20 manholes, 6,000 ft 10-18 in. vitr. pipe. About $134,210. J. F. Byxbee, Jr., Palo Alto, Engr.

Cal., Santa Ana—Construction work will start in March on North Main street, First street to city limits. Paving will be 6-in. conc. base and 2-in asph. surface.

Colo., Ft. Collins—Petition signed by residents presented to Council urging that paving of West Mountain avenue be postponed no longer. City Engr. Cheek estimates cost of the work at $184,752, or somewhere near that figure.

Colo., Manitou—Prelim. surveys being made for paving Ruxton avenue, Hiawatha Gardens to foot of Pike's Peak. About $150,000. Wieland Engineering Co., 717 Thatcher Bldg., Pueblo, Engrs.

D. C., Washington—Special government aid for constr. of 9,630 miles national hwys. approved by U. S. Dept. of Agriculture. Mileage which will be constructed with federal aid on each of the several trails is as follows: Dixie Hwy., 895 mi.; Ozark Trails, 294; Yellowstone Trail, 455; Bankhead Hwy., 963; Meridian Hwy., 677; National Old Trails, 826; King of Trails, 474; National Parks Hwy., 647; Theodore Roosevelt International Hwy., 425; Jefferson Hwy., 604; Lincoln Hwy., 766; Old Spanish Trail, 618; Mississippi Valley Hwy., 237; Dixie Overland Hwy. 259; Jackson Hwy., 161; Pacific Hwy., 183; Roosevelt National Hwy., 314; Colorado-to-Gulf, 122; Pike's Peak Ocean to Ocean, 319; Atlantic Hwy., 140; miscellaneous, 452—total, 9,630.

Fla., Marianna—Jackson Co. Commrs., Marianna, Fla., and State Hwy. Dept., Tallahassee, Fla., will construct 35 miles of hwy. from Calhoun county line to Alabama state line, 14 ft. wide; bitum. macadam or asph. concrete. Chas. A. Browne, St. Hwy. Engr., Tallahassee, Fla.

Ill., Chicago—Board of Local Impvts. announces that approximately 150 miles streets and alleys will be paved this year. Cost of city's hwy. program for year may reach $8,500,000. Following are principal projects either agreed upon or contemplated by the Board, Julius G. Gabelman, Chief Street Engr.: Indianapolis avenue will be paved from Ewing avenue to Indiana state line. Sandstone blocks will be used; paving of Norwood Park avenue, Milwaukee avenue and Jefferson street through to Oketo avenue, Norwood Park. It is planned to lay brick from Milwaukee to Austin avenues. (Austin to Bryn Mawr is a short stretch outside city limits which county has agreed to pave.) Board plans to lay asphalt from Bryn Mawr to Raven avenue, except 1 block east of Raven, which will probably be of sandstone block. This route will be about 2 miles. Roadway is 30 ft. wide and street 66 ft. wide. Third project contemplated is paving North Western avenue, Foster to Devon avenues. Brick will probably be used. Paving of Addison street, Long avenue to city limits, two and one-fourth miles, asphalt, is also 6,500 west; paving of North Central avenue, Irving Park boulevard south to West Grand avenue, is also contemplated. Board has ordered paving of Archer avenue to city limits.

Ill., Bloomington—City Commrs., at meeting, voted to take preliminary steps towards laying of 50 blocks new brick pavement, which will cost approximately $250,000.

Ia., Cedar Rapids—Bids will be called about March 15 for curb and gutter on Oakland Rd., G avenue to J avenue, and on Thirtetnth street, G avenue to J avenue, about 3 miles. City Engr. T. F. McCauley, City Engr.; City Clerk, L. J. Storey. Bids will be asked about same date also for repaving South Third street east from Fifth to Sixteenth avenue, eleven blocks. Bids will be on brick paving, asph., asph.-conc. City Engr., T. F. Mcplanned; also Irving Park boulevard, 400 west to Cauley, Engineer.

Ia., Davenport—Ready for bids about March 1 for county road paving (Scott county). J. M. Malloy, Engr., Court House. Plans under way. C. Marti, Chmn. Bd. of Supvrs.

Kans., Topeka—Plans for street impvts. here, costing approx. one-half million dollars announced by City Commrs. Of this amount $300,000 is for street paving.

Ky., Smithland—State Hwy. Dept., Frankfort, Ky., will construct 32 miles F. A. Hwy., Livingston county (Ohio River Route); will invite bids in spring; $554,000 available.

Md., Baltimore—Streets in Old Annex, to be paved, decided upon by Paving Commission. Program calls for about 4 miles of paving in Old Annex alone. City will make announcement for paving in New Annex in the near future.

Minn., Duluth—St. Louis county has appropriated $2,166,000 and will let contracts in spring for surfacing and extending roads; also building bridges during 1921. About $958,010 of above amount will be apportioned to carrying out of work calculated to benefit county as a whole, while balance of

BUYERS' GUIDE

Dust Laying Compound.
Barber Asphalt Paving Co.
The Barrett Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Sinclair Refining Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Grab Buckets.
Mead-Morrison Mfg. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.
Barber Asphalt Paving Co.

Hydrants.
Flower Valve Mfg. Co.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Iron Fence.
Cincinnati Iron Fence Co.

Joint Fillers (Paving).
The Barrett Co.

Kettles (Portable).
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
Lakewood Engineering Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barber Asphalt Paving Co.
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.

Paving Joint Filler.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Cach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Barber Asphalt Paving Co.
Kentucky Rock Asphalt Co.
Sinclair Refining Company.
The Texas Co.

$1,207,990 will be apportioned between Commissioners' districts.

Minn., Duluth—City Commrs. plan to pave Second street, 258 ft. west of Fourth avenue, to west line of Twenty-sixth avenue east. Bitulithic, 42 ft. wide, approx. 3 miles; also pave Superior street, Twenty-third avenue east to east line of Sec. 12 with asph., 45 ft. wide. J. A. Farrell, Commr. Estimated cost of both improvements, $284,500 and $208,003, respectively.

Minn., Redwood Falls—City will spend $200,000 for street paving and sewer construction. Work will start in spring. H. C. Rutter, Clerk.

Minn., St. Paul—First paving order for 1921 introduced in Council. It was prelim. order calling for paving of Hastings avenue, Earl street to Pt. Douglas Rd. and Pt. Douglas Rd., Hastings avenue to southern city limits—total distance of 5 miles. Cost from $350,000 to $400,000. County Board has appropriated $135,000 toward cost.

Miss., Canton—Bd. of Supvrs. Madison Co. has authorized H. C. Dietzer, St. Hwy. Engr., to survey and prepare specfs. for about 11 miles Fed. Aid roadway, extending from Sharon, 6 miles east of Canton, to Leake county line.

Miss., Jackson—$305,000 Fed. Aid apportioned to two counties for road building. Hinds county will receive $125,000 for constr. of 10 miles concrete road between Jackson and Clinton, and a coast county will get $180,000 to assist in building 18 miles conc. hwy. from Harrison county line to W. Pascagoula River by way of Ocean Springs.

Mo., Greenville—Wayne Co. Commrs. considering constr. of 15-mile State Hwy. from Piedmont to Silva; $203,000.

Mont., Helena—State Hwy. Comn. anticipated awarding contracts for roads and bridges during 1921 totaling 175 miles. Estimated cost, $2,250,000.

Neb., Beatrice—New state roads in north and south part of Gage county will be included in road impvt. program. Co. Bd. of Supvrs. have made application for federal and state aid for gravel surfacing Lincoln Hwy. across county (Buffalo). Gilbert E. Haase, Aud. Buffalo Co.; Ben H. Zeifkes, Supvr. Gage Co. Antelope county will start work in spring on constr. of perm. hwys. in county. P. H. Peterson, Aud. Shelby, Neb., has passed Grade Ord. 113 for grading and paving Districts 1 and 2. F. M. Leibee, Vil. Clk.

Neb., Nebraska City—Otoe county will grade 40 mi. F. A. Rd., to pass through Palmyra, Unadilla, Syracuse and Dunbar to Nebraska City, and connect with Kansas City-Omaha road. Herbert Schwader, Engr. Oliver Stevenson, Co. Aud.

N. J., Trenton—City plans street improvement work costing about $305,967. A. Swan, City Engr.

N. C., Raleigh—Plans being prepared for clearing, grubbing, grading, top-soiling, draining, building culverts and bridges on 9.8 miles Charlotte-Asheville Hwy. 16 ft. wide, F. A. Proj. 78C, Rutherford county, $90,000; 10 mi. hwy. between Marion and Asheville, F. A. Proj. 84D, McDowell county, $150,000; 8 mi. Sparta-Elkin Hwy. 12 ft. wide, F. A. Proj. 125B, macadam, Alleghany county, $165,000; 4 mi. road between Chapel Hill and Orange-Durham county line, 18 ft. wide, F. A. Proj. 110, Orange county, $125,000. Latter road will be paved in sections representing all the more common types hard surf. for experimental purposes, and will have one 100 ft. and one 80 ft. rein. bridge on same. W. S. Fallis, State Hwy. Engr.

N. C., Washington—Beaufort Co. Comrs. will hard surface 10 miles of roads, $400,000 available. Gilbert C. White, Engr., Durham.

O., Cleveland—Co. Commrs. authorized paving West Madison avenue, city limits to Rocky River. Work will cost about $300,000, and will begin early in spring or early summer.

O., Youngstown—City will receive bids early in spring for grading portions of about five streets; grading and macadamizing portion of Bond street; paving portions of about 21 streets. F. M. Lillie, Cons. Engr. G. F. Turner, City Engr.

Okla., Okmulgee—City will soon receive bids for resurfacing practically all streets in business section and laying 73 blocks of pavement in residential districts; brick and asphalt. About $1,000,000.

Pa., Philadelphia—Complete reconstruction of many of city's most important streets have virtually been decided upon by City Council. A $5,000,000 hwy. constr. program, with short-term loan funds, is being worked out. Plans include city's cent. streets, including modern paving of Callowhill, Vine, Race, Spruce, Pine and Lombard streets. Additional bills filed calling for paving of every main traffic artery in city, including particularly diagonal streets, such as Ridge, Germantown, Kensington, Frankford, Woodland, Baltimore and Gray's Ferry avenues. Dressed granite blk. on conc. base and closely cemented together would be used for paving of these streets. If Legislature passes bill permitting reconstr. of hwys in this city with short-term loans the five million dollar program will be launched this year.

S. C., Greenwood—City plans paving Maxwell avenue, 600 yards, also other streets; $200,000 available.

Tenn., Jasper—$250,000 bonds voted to construct 50-mile Dixie Hwy. through here. Fed. Govt. and state will appropriate toward cost.

Tenn., Knoxville—City will improve 12 streets. J. Boyd McCalla, Commr.

Tex., Dallas—Plans prepared for widening and paving 1 mile Ross avenue, Lamar street to Houston & Tex. Cent. R. R., 80 ft. wide. About $250,000. G. D. Fairtrace, City Engr.

Tex., Brenham—Prelim. surveys being made by G. A. Bracher, Co. Hwy. Engr., for constr. of 31 miles State Hwy. No. 20, Washington county, Carmine to Brazos River; $500,000 county road bonds voted and $325,000 F. A. available for project—total, $825,000. Co. Judge Chappell, Brenham.

Tex., Nacogdoches—Co. Commrs. will constr. 9.7 miles State Hwy. No. 35, Nacogdoches to Angeline county line. Estimated cost, $118,207. Lamar Acker, Co. Engr.

Tex., San Marcos—Plans for constr. of 17.8 mi. Austin-Fredericksburg road, Hays county, to be graded, and 3.7 mi. surfaced with crushed rock, approved by U. S. Dist. Engr., Ft. Worth. J. W. Puckett, Co. Engr., San Marcos, Tex.

Tex., Pittsburg—Camp county plans to construct, in near future, 9.92 mi. gravel macadam road on State Hwy. No. 1-A. Estimated cost, $67,000. Bond issue, $535,000, voted for road construction; funds available. Wilder & O'Neal, Mt. Pleasant, and J. A. Efrud, Co. Judge, Pittsburg.

Va., Norfolk—City Mgr. Chas. E. Ashburner plans street impvts. costing $1,265,263, including extension of Olney Rd., Monticello to Highland avenue, at cost of $112,110; resurfacing Main street, Boush street to Lake avenue, and other streets.

Wash., Olympia—Seventeen of the thirty-nine counties in state have issued bonds for road building purposes. Total for state, including 1920, is $13,244,800. Road bonding record by counties is as follows: Chelan, $830,000; Clallam, $300,000; Clarke, $150,000; Franklin, $115,000; Grays Harbor, $1,600,000; Mason, $250,000; Pacific, $436,000; Pierce, $2,500,000; Skamania, $210,000; Snohomish, $1,813,000; Spokane, $3,250,000; Thurston, $600,000; Wahkaikum, $75,000; Walla Walla, $265,000; Yakima, $500,000; Kittitas, $50,000; Kitsap, $300,000.

Wis., Appleton—Co. Board Outagamie Co. has appropriated following sums for road construction in county: $24,000 for patrol maint. fund; $30,000 to meet state and fed. aid on Proj. 232, Trunk Hwy. 18; $16,333.33 to meet state and F. A. on Proj. 231, Trunk Hwy. 54; $12,000 for filling gap on Shiocton-Shawnee Rd.; $45,000 for work on Appleton-Seymour Rd.; $19,000 for additional work on Bear Creek-New London Rd.; $45,000 on Greenville-Shiocton Rd.; $22,500 on Little Chute Hill on Appleton-Kaukauna Rd., Trunk Hwy. 15. A. G. Brusewitz, Appleton, Commr.

Wis., Friendship—Bids will be called in spring by State Hwy. Comn. Madison for grading and surfacing Friendship-Arkdale Rd. (about 7 miles). J. A. McGregory, Co. Hwy. Commr., Friendship.

Wis., Madison—City Engr. E. E. Parker roughly estimates cost of paving program for 1921 at $1,111,075.

Wis., Superior—Resolution passed by city to pave Twenty-first street, Tower avenue to New York avenue, 1 mile, paving with concrete, 40 ft. wide. M. G. Beckleu, City Clk. Estimated cost, $100,000.

Wis., Wausau—Bids will be taken in spring by St. Hwy. Comn. for following road projects: Marshfield-Abbotsford Rd., grading and surfacing with gravel 14 miles on Hwy. 13; 60,000 cu. yds. excav., 130,000 cu. yds. grav. surf., 760 cu. yds. conc. in structs; Merrill-Wausau Rd., grading and surfacing with gravel 5 miles Hwy. 10; 19,500 cu. yds. excav., 48,000 sq. yds. surface, 375 cu. yds. conc. in structures. H. J. Vogt, Wausau, Co. Hwy. Commr.

BUYERS' GUIDE

Road Binder.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Sinclair Refining Company.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Lakewood Engineering Co.
Mayer, F.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The
American Road Plane Co.

Road Oil and Preservatives.
Barber Asphalt Paving Co.
The Barrett Co.
New Orleans Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.

Road Tampers.
Lakewood Engineering Co.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.

Saw Rigs.
C. H. & E. Mfg. Co.

Sandstone.
Cleveland Stone Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnishchfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
Clay Products Association.

Sewer Rods.
Stewart, W. H.

Sidewalks (Stone).
Cleveland Stone Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.

Special Castings.
Crane Co.
Flower Valve Mfg. Co.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Curbing.
Cleveland Stone Co.

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Flagging.
Cleveland Stone Co.

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co.

Street Crossings.
Cleveland Stone Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
Barber Asphalt Paving Co.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Elgin Sales Corp.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.

Tar and Pitch.
The Barrett Co.
Philip Carey Co., The

Tar Heaters.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.

Trench Braces.
Kalamazoo Fdry & Mich. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger

Trinidad Lake Asphalt.
Barber Asphalt Paving Co.

Turbines, Steam.
De Laval Steam Turbine Co.

Valves.
Coldwell-Wilcox Co.
Flower Valve Mfg. Co.

Wall Coping.
Cannelton Sewer Pipe Co.

Warranite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Waterproofing.
Barber Asphalt Paving Co.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau.
Coldwell-Wilcox Co.
Flower Valve Mfg. Co.
Mueller Mfg. Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Winches, Vertical Capstan or Friction Drum.
Mead-Morrison Manufacturing Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Republic Creosoting Co.

Wood Preservatives.
Barrett Co., The
Republic Creosoting Co.

Wis. Washburn—Bids taken in spring by St. Rd., on Trunk Hwy. 24, 8½ miles. John Friberg, Co. Hwy. Commr., Bayfield Co.

SEWERAGE AND SEWAGE TREATMENT

Cal., East San Diego—Olmsted & Gillelen, Cons. Engrs., Hollingsworth Bldg., Los Angeles, have prepared plans for proposed new outfall and intercepting sewers for East San Diego. Lines will require abt. 40,000 ft. 8-in. to 16-in. pipe. $100,000 bonds voted and bids will be asked as soon as bonds are sold. Lat. sewers will be built later under dist. assessment plan.

Cal., Long Beach—City Engr. A. de Ruiz has completed plans and specfs. for first unit proposed storm sewer system for Long Beach. Est. cost $224,000. Drains will range from 10 and 12 inches to 4½ ft. rein. conc. pipe.

Cal., Los Angeles—Bd. Pub. Wks. has approved plans for proposed new outfall sewer for City and recommended to Council that elec. be held not later than March 31 to vote on bond issue for proj. Est. cost $12,200,000.

Colo., Greeley—Plans prepared for storm and san. sewerage systems. Abt. $325,000. R. W. Gelder, City Engr. Burns & McDonnell, Interstate Bldg., Kans. City, Mo., Cons. Engrs.

Ill., Aurora—City will receive bids in Spring or Summer for bldg. sewerage system here. Abt. $225,000.

Ill., Benton—Ord. passed by City for construct. sewers, manholes, etc., throughout entire city. Work involves 110,156 ft. 6 to 30-in. vitr. pipe, 86,705 cu. yds. earth and 1,650 cu. yds. rock trenching, 248 brick manholes. Abt. $248,671. C. B. Mautz, Benton, Engr.

Ill., Farmington—Ord. passed for sewer system here estimated to cost $98,779.

Ia., Cedar Rapids—Bids in about April 1 for sanitary sewers. Abt. 3 miles 6, 8 and 10-in. sewers in First Ave. and 27th St. Dist. City Engr. T. F. McCauley. L. J. Storey, City Clk.

Ky., Paducah—Under provisions of Ord. adopted by City Commrs., project for creation of third sewer dist, to include all territory in city not in dists. 1 and 2, is authorized. Constr. will begin at earliest possible moment. $250,000 bonds will be sold.

Md., Baltimore—City Comn. considering constr. of sewer system in Brooklyn-Curtis Bay Dist. Est. cost $2,129,950. A. C. Christhilf, City Engr.

Mich., Detroit—Plans being prepared for increasing capy. sewage pumping station. Work includes installation addtl. equipt., coal handling equipt. constr. brk., steel and conc. bldg. and erection new stack at Fairview pumping station. Abt. $80,000. Smith, Hinchman & Grylls, 710 Washington Arcade, Engrs.

Mich., Stambaugh—City plans to build sewerage system here. About $70,000. Greely, Pearse & Hansen, 39 W. Adams St., Chicago, Engrs.

Minn., Columbia Heights—Plans being prepared and bids will probably be asked in Spring for bldg. sewerage system covering abt. 4 sq. mi.. Election soon to vote on $450,000 bonds for project. J. W. Shaffer & Co., 917 N. Y. Life Bldg., Minneapolis, Engrs.

N. C., Graham—Town has issued $100,000 bonds to install san. sewer system. P. A. Holt, Clk.

N. J., Dover—Jersey City plans to construct main sewer and disposal plant here, for protection of Jersey City water pipe line. About $2,000,000.

N. C., Asheville—City will extend sewer system in West Asheville. Est. cost $70,000; construct 3 main trunks and several lat. lines.

Okla., Duncan—City Commrs. have retained Johnson & Benham, Cons. Engrs., Firestone Bldg., Kans. City, Mo., to prepare plans, specfs. and ests. for system of storm sewers and additional street paving impvts. Est. cost of work $750,000. R. W. Cline, City Mgr.

W. Va., Spencer—City will improve sewerage system; prelim. survey made to construct disposal tank. Total cost $100,000. E. W. McKnown, Mayor.

Wis., Antigo—Plans being drawn to combine 3rd and 4th Wards into one Sewerage Dist. Storm sewer to be built on 5th Ave.—Hudson to Field and 5th, sewer from 4th Ave. and Superior east on 4th Ave. to Edison; thence no. on Edison to Mendlick; on 6th Ave. from C. & N. W. Ry. to Springbrook. Est. cost $60,000.

Wis., Franksville—Village contemplates constr. of 4½ miles sewerage system in connection with proposed Hood Creek D. D. Abt. $100,000. Engineer not selected.

Wis., Hartford—J. Donohue, Engr., 720 N. Y. Ave., Sheboygan, retained by City to prepare plans for altering sewerage system, bldg. septic tank and paving various streets. Abt. $50,000. W. Radke, Clk.

WATER SUPPLY AND PURIFICATION

Ala., Birmingham—Birmingham Water Works Co.—Harry Horner, Supt.—will improve water works costing betw. $450,000 and $500,000; will issue $700,000 bonds; install 2 pumps, 10,000,000-gal. and 5,000,000-gal. capys. respectively. I. W. Ross, City Engr.

Cal., Avalon—Resolution adopted by City Trustees to improve portions Crescent Ave. and 7 other straeets, including laying 4-in. and 6-in. cast iron water mains and placing fire hydrants. Annonucement also made by Wm. Wrigley, Jr., owner of Catalina Island that complete water system for Island resorts will be built. Water will be carried from the mtns. to coast by means of tunnels. Constr. of 1st tunnel will be started immediately.

Cal., Fullerton—Engr. J. B. Lippincott has submitted report to Bd. of Trustees in which he estimates that it will cost abt. $320,000 to construct water system. Included in estimate is $15,200 for pumps, $221,000 for distributing system; $4,000 for replacing pavement and $62,000 for reservoir.

Cal., Los Angeles—So. California Edison Co. authorized by Railroad Comn. to issue $10,000,000 bonds. Company estimates it will expend $8,000,000 for hydro-electric development in 1921 and addns. and impvts. will cost four to six million dollars.

Cal., Modesto—City will receive bids about April 1st for bldg. Don Pedro Dam; rein. conc. gravity arch type, 1,000 ft. long, 270 ft. thick at base, 16 ft. at top and 283 ft. high above stream bed. Cost, including dam and power development proj. which will take 2 yrs. to complete, $3,075,000.

Cal., Riverside—Budget of Southern Sierras Power Co. for 1921, carries appropriations amounting to $2,183,329 for constr. work. Among items is $600,000 for additional hydro-electric developments; $208 000 for rebldg. distributing lines in Imperial Valley.

Fla., So. Jacksonville—City will extend water system and pave streets; voted $100,000 bonds. E. M. Gibbon, City Engr.

Ia., Cedar Rapids—City will open bids about May 1st for bldg. new reservoir, water mains and repairing water works plant. Abt. $200,000. T. F. McCauley, City Engr.

Kans., Parsons—City having plans prepared for rehabilitation of water works plant, involving 7 miles new main discharge lines, rebldg. power plants, installing filter equipt. and machy. for 6,000,000-gal. capy. Abt. $350,000. Burns & McDonnell, Engrg. Co., Interstate Bldg., Kansas City, Mo., Cons. Engrs.

Pa., Harrisburg—Water supply extension will be started this year and to complete whole program outlined will cost City $1,000,000. Public voted by big majority in favor of loan and this year $800,000 will be raised by bond issue. Jas. H. Fuertes, engaged as Cons. Engr., to prepare plans and specfs., also to supervise construction. Filter plant addns., boilers, sedimentation and coagulation basins, new intake in river, more pumps at pumping sta., street main extensions and new reservoir are some of the impvts. which will be provided with money now available.

Tex., El Paso—City (Chas. Davis, Mayor) plans electrical development of Elephant Butte dam, including erection giant generators, main power plant, sub-stations and transmission lines. Est. cost $4,000.

Tex., Whiterock—Plans being prepared for constr. of purification plant and impvts. to water works at approx. cost of $450,000.

Tex., San Antonio—San Antonio Water Supply Co.—B. E. Chandler, Pres.-Treas.—will build 20,000,000-gals. capy. reservoir; purchased 83-acre site. Est. cost of reservoir $250,000.

Wash., Seattle—Two bills, providing for further extensions at Cedar Falls, passed by Council. One appropriates $85,000 for remodeling power plant and installation of machinery; the other appropriates $115,000 for additional pipe line betw. Cedar River basin and power plant.

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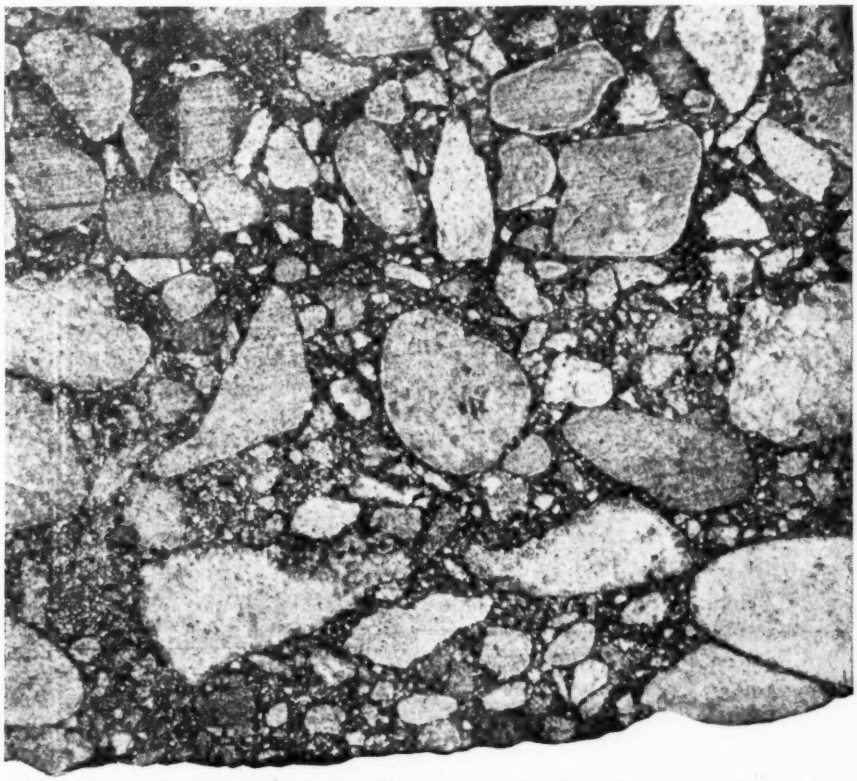

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* * * * *

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* * * *

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* * * *

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